# Bayou Cocodrie Implementation Plan for Dissolved Oxygen and Nitrogen, Total Dissolved Solids and Turbidity

## EXECUTIVE SUMMARY

The Bayou Cocodrie watershed is 429 sq miles and composed of forested areas (48%), water and wetlands (21%), agricultural crops (20%), and pasture (11%). There are 5 LDEQ subsegments in the watershed (060101, 060102, 060201, 060202, 060203), which are relatively undeveloped. Less than 1% of the watershed is composed of urban areas and only 20% is currently being utilized for agriculture, which consists of a rice/soybean rotation (~48%) and some cotton (~15%), sugarcane (~16%), corn (~11%), and miscellaneous production such as crawfish and milo. Compared to other watersheds in the basin, the Cocodrie watershed is relatively pristine and 2 of 5 subsegments (060101, 060102) include stream reaches that are considered “outstanding natural resource waters”. Subsegments 060102 and 060201 have received new dissolved oxygen (DO) criteria since the waterways were modeled in the TMDL and these stream reaches have to be rerun to reflect the new standards. Implementation strategies for this watershed shall be revised once these sections have been reevaluated with the new criteria.

## Table of Contents

# 1.0 Implementation Plan for Dissolved Oxygen, Nutrients, and Total Dissolved Solids

## 1.1 INTRODUCTION

A TMDL is an acronym for Total Maximum Daily Load, which is the maximum amount of a pollutant that a water body can assimilate and still meet water quality standards for its designated uses. If the water body does not meet the standard for a particular use, a set percentage of the time (depending on the standard) it is placed on the State of Louisiana's 303(d) List of Impaired Waters. The watershed is composed of 5 subwatersheds (Sub-segment 060101, 060102, 060201, 060202, and 060203) and some of these subsegments were listed on the 1998 303(b) list of impaired waterbodies as not meeting its designated uses for fish and wildlife propagation. Therefore, the Louisiana Department of Environmental Quality (LDEQ) has completed a TMDL for Dissolved Oxygen (DO)for subsegments 060102, 060201, and 060203. The U.S. Environmental Protection Agency (USEPA) Region 6 has completed and released TMDLs for nutrients and total dissolved solids (TDS), which are based on the LDEQ DO TMDL reductions.

An Implementation Plan describes a plan of action to reduce NPS pollution in the watershed until the streams and rivers will comply with water quality standards. These plans will be the basis for outlining how and where the State's NPS Program focuses its efforts and future resources within the watershed in order to achieve use attainment by the year 2008, as agreed upon with EPA. In agricultural watersheds, such as the Cocodrie, the implementation of best management practices (BMPs) such as conservation tillage, riparian zones, and precision farming (BMPs) are the recommended course of action for reducing pollutant runoff from row crops, rice, and pasture. Recent innovations in rice BMPs should prove to be a winning strategy for reducing NPS pollution in the watershed as much as 60%. Hydromodification, home sewerage, and urban runoff also contribute to low DO conditions and high levels of TSS, turbidity, and TDS. BMPs for these NPS pollutant sources will also be presented in this plan.

## TMDL FINDINGS

TMDL findings are not applicable at this time. In the near future, the TMDL will be revised and this Implementation Plan will be revised to reflect those changes.

## TIMELINE FOR IMPLEMENTATION PLAN

This Implementation Plan for the watershed restoration actions will be submitted to the EPA. This document outlines a 5-year management plan to reduce NPS pollutants from reaching the waterways. The LDEQ water quality team intensively samples each watershed in the state once every 5 years to see if the water bodies are meeting water quality standards. This 5 year cycle of water quality sampling began in 1998 in the Bayou Cocodrie and will occur again in 2003, 2008, and 2013. In 2003, LDEQ will sample the bayou to see if there has been any improvement since 1998. In 2008, LDEQ will sample again in the watershed to see if the waterway has improved as the result of BMPs recommended in the Watershed Implementation Plan. If not, LDEQ will revise the Implementation Plan to include additional corrective actions to bring the waterway into compliance. Additional BMPs will be employed, if necessary, beginning in 2009 and increase until water quality standards are achieved by 2013. The long-term goal for restoring the waterway is 2015. The data from 2003 will be considered baseline from which to measure the rate of the water quality improvement in samples taken in subsequent years. The data collected in 2008 will be used to determine if the implementation of management measures in the Implementation Plan have been effective and whether additional corrective actions will need to be implemented until the water body meets criteria by the year 2015.

## FEDERAL AUTHORITY

Section 319 of the Clean Water Act (PL 100-4, February 4, 1987) was enacted to specifically address problems attributed to nonpoint sources of pollution. Its objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Sec. 101; PL 100-4), which instructs the Governor of each State to prepare and submit a Nonpoint Source Management Program for reduction and control of pollution from nonpoint sources to navigable waters within the State by implementation of a four-year plan (submitted within 18 months of the day of enactment).

## STATE AUTHORITY

In response to the federal law, the State of Louisiana passed Revised Statute 30:2011, signed by the Governor in 1987 as Act 272. Act 272 designated the Louisiana Department of Environmental Quality as the "Lead Agency" for development and implementation of the State's Nonpoint Source Management Plan. The Louisiana Revised Statutes R.S. 30:2011.D (20) includes the following provision as the authority for LDEQ to implement the State's NPS Program.

To develop and implement a non-point source management and ground water quality protection program and a conservation and management plan for estuaries, to receive federal funds for this purpose and provide matching state funds when required, and to comply with terms and conditions necessary to receive federal grants. The nonpoint source conservation and management plan, the groundwater protection plan, and the plan for estuaries shall be developed in coordination with, and with the concurrence of the appropriate state agencies, including but not limited to, the Department of Natural Resources, the Department of Wildlife and Fisheries, the Department of Agriculture and Forestry and the State Soil and Water Conservation Committee in those areas pertaining to their respective jurisdictions.

## TABLE 1.1

## Revised Timeline for Watershed Planning and Implementation

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mermentau** | | | | | | | | | | | | | | | | | | | |
| **Vermilion** | | | | | | | | | | | | | | | | | | | |
| **Calcasieu** | | | | | | | | | | | | | | | | | | | |
| **Ouachita** | | | | | | | | | | | | | | | | | | | |
| **Barataria** | | | | | | | | | | | | | | | | | | | |
| **Terrebonne** | | | | | | | | | | | | | | | | | | | |
| **Pontchartrain** | | | | | | | | | | | | | | | | | | | |
| **Pearl** | | | | | | | | | | | | | | | | | | | |
| **Red** | | | | | | | | | | | | | | | | | | | |
| **Sabine** | | | | | | | | | | | | | | | | | | | |
| **Mississippi** | | | | | | | | | | | | | | | | | | | |
| **Atchafalaya** | | | | | | | | | | | | | | | | | | | |

1- Black Stripes = Collect Water Quality Data to Develop Total Maximum Daily Loads (TMDLs) and to Track Water Quality Improvement at the Watershed Level **[Objective 1]**
2- Light Blue = Develop Total Maximum Daily Loads for the Watersheds on the 303(d) List [**Objective 2]**
3- Green = Develop Watershed Management Plans to Implement the NPS Component of the TMDL **[Objective 3]**
4- Yellow = Implement the Watershed Management Plans **[Objectives 4-8]**
5- Dark Blue = Develop and Implement Additional Corrective Actions Necessary to Restore the Designated Uses to the Water Bodies **[Objective 9-10**

**Table 1.2** The Attainable and Designated Uses of the Bayou Cocodrie are the numerical criteria to insure Louisiana's waterways maintain safe levels for human health, propagation of fish and wildlife, and maintenance of recreational uses. As you can see from the table below, the Bayou Cocodrie is meeting criteria for primary and secondary recreation and not meeting the criteria for the propagation of fish and wildlife (DO, TDS, TSS, and Turbidity standards).

**Table 1.2 Summary of designated uses and water quality information for the Bayou Cocodrie watershed**

| Waterbody Bayou Cocodrie<br><br>Subsegment | NPS related parameters for which numerical standards have been developed | Standard (From LDEQ Environmental Regulatory Code) | Does waterbody meet designated uses? (From 2002 305(b) Report) | Suspected causes of impairment |
|---|---|---|---|---|
| 060101 | Primary Contact Recreation<br>Secondary Contact Recreation<br>Fish and Wildlife Propagation | [1]<br>[2]<br>[3] | Yes<br>Yes<br>Partially | Turbidity, Total Suspended Solids, Sedimentation/siltation. |
| 060102 | Primary Contact Recreation<br>Secondary Contact Recreation<br>Fish and Wildlife Propagation | [1]<br>[2]<br>[3] | Yes<br>Yes<br>No | DO/Organic enrichment, Non-native Aquatic Plants, Nitrogen/ammonia |
| 060201 | Primary Contact Recreation<br>Secondary Contact Recreation<br>Fish and Wildlife Propagation | [1]<br>[2]<br>[3] | Yes<br>Yes<br>Partially | Sedimentation/siltation, Copper, Total Suspended Solids, Turbidity |
| 060202 | Primary Contact Recreation<br>Secondary Contact Recreation<br>Fish and Wildlife Propagation | [1]<br>[2]<br>[3] | Yes<br>Yes<br>Partially | Turbidity, Total Suspended Solids,, Sedimentation/siltation. |
| 060203 | Primary Contact Recreation<br>Secondary Contact Recreation<br>Fish and Wildlife Propagation | [1]<br>[2]<br>[3] | Yes<br>Yes<br>Partially | Non-Native Aquatic Plants, Total Suspended Solids, Sedimentation/siltation, Mercury, Turbidity |

[1] Based on a minimum of not less than five samples taken over not more than a 30-day period. Fecal coliform count should be less than 200 /100ml over a 30-day period, and less than 10 % of samples during any 30-day period or 25 % of total samples collected annually can exceed 400/100ml. Applies only May 1 – Oct. 31, otherwise, criteria for secondary contact recreation applies.

[2] Based on a minimum of not less than five samples taken over not more than a 30-day period Fecal coliform count should be less than 1000 /100ml in at least 5 samples taken over a 30-day period, and less than 10 % of samples during any 30-day period or 25 % of total samples collected annually can exceed 400/100ml.

[3] Fish and Wildlife Propagation assessment involve measuring DO and oxygen demanding materials such as TSS, Turbidity, Noxious plants, etc. LDEQ has developed criteria for some of these materials.

## DESCRIPTION OF BAYOU COCODRIE WATERSHED

The Bayou Cocodrie watershed is located in southern Louisiana in the Vermillion-Teche Basin between Alexandria and Lafayette. The components of the system include Spring Creek, Cocodrie Lake, Bayou Cocodrie from Cocodrie Lake to the confluence with the Diversion Canal, Bayou Boeuf-Cocodrie Diversion Canal from near Lecompte to Bayou Cocodrie, Lake Chicot, Bayou Chicot from Lake Chicot spillway to the confluence with Bayou Cocodrie, and Bayou Cocodrie from the confluence with the Diversion Canal to the mouth. The watershed includes rolling, hilly areas that are forested as well as flat, lowland areas that include cropland, forests and swamps.

Cocodrie Lake is a shallow lake that is mostly covered with trees. The depth is only about 3 ft. Inflows to Cocodrie Lake include the upper part of Bayou Cocodrie, Spring Creek, Little Spring Creek, and Hurricane Creek. The total drainage area of Cocodrie Lake is approximately 227 $mi^2$. The outlet of Cocodrie Lake consists of an uncontrolled overflow spillway across the channel of Bayou Cocodrie near Highway 167. The lake can be drawn down below the spillway level via a bypass valve and a control. (Bayou Cocodrie Watershed TMDL Report for Dissolved Oxygen, 2000)

Downstream of Cocodrie Lake, Bayou Cocodrie flows generally southeast. Inflows to Bayou Cocodrie downstream of Cocodrie Lake include Bayou Chicot and the Bayou Boeuf-Cocodrie Diversion Canal. Bayou Cocodrie from Highway 167 to the confluence with the Bayou Boeuf-Cocodrie Diversion Canal has been designated as an outstanding natural resource waterbody by LDEQ.

The Bayou Boeuf-Cocodrie Diversion Canal is a man made channel that allows water to be diverted away from Bayou Boeuf near Lecompte. The Diversion Canal flows southeast from near Lecompte to the point where it merges with Bayou Cocodrie southeast of St. Landry. Flow into the Diversion Canal is regulated by a weir across the Diversion Canal located several hundred feet downstream of the main channel of Bayou Boeuf. When the water level in Bayou Boeuf rises above the top of the weir (during floods), large amounts of water can flow into the Diversion Canal. During low flow periods, the only water that flows from Bayou Boeuf into the Diversion Canal is through an orifice in the Weir. The orifice is approximately 1-2 ft in diameter and is positioned several feet below the crest of the weir.

Lake Chicot is an impoundment that was created by building a dam across Bayou Chicot. The dam has an uncontrolled overflow spillway that functions as a weir. The lake is approximately 16-17 ft deep near the dam. There are many trees in shallower parts of the lake, particularly near the upstream (south) end. The drainage area of Lake Chicot is approximately 36 $mi^2$ (USGS, 1971).

Downstream of Lake Chicot, Bayou Chicot flows approximately 1.6 miles before entering Bayou Cocodrie. There are no significant inflows to this reach of Bayou Chicot. (Bayou Cocodrie Watershed TMDL Report for Dissolved Oxygen, 2000).

Downstream of Bayou Chicot and the Diversion Canal, Bayou Cocodrie continues flowing southeast until it ends at its confluence with Bayou Boeuf. Part of this reach of Bayou Cocodrie consists of a straight, man-made channel that cuts through the original meandering channel. In this area, each "oxbow" created by the new channel is blocked at one end so that all of the flow is forced through the man-made channel. The total drainage area for Bayou Cocodrie (at the confluence with Bayou Boeuf) is approximately 429 sq miles. The confluence of Bayou Cocodrie and Bayou Boeuf forms the upstream end of Bayou Courtableau. (Bayou Cocodrie Watershed TMDL Report for Dissolved Oxygen, 2000)

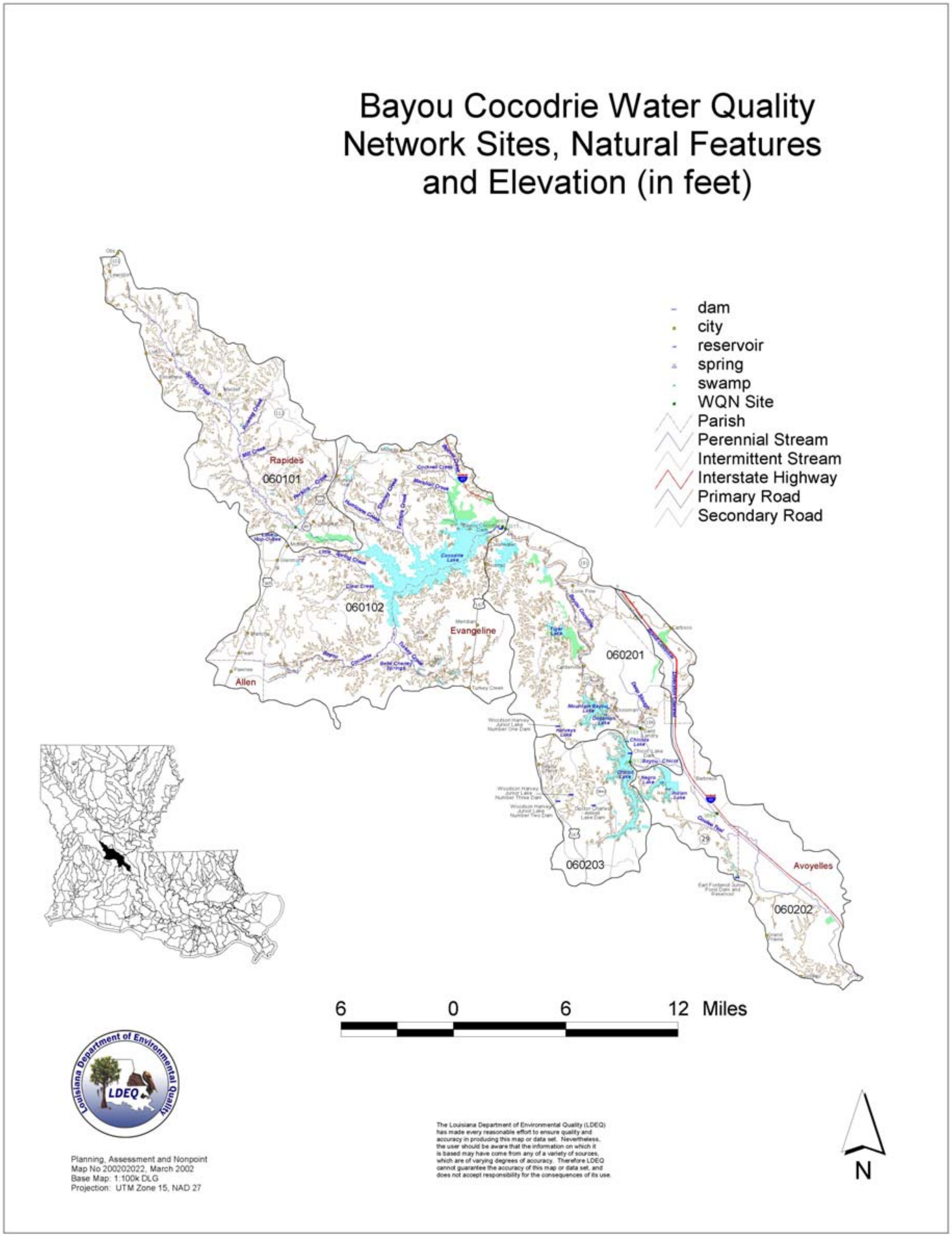



**FIGURE 1.1** Bayou Cocodrie watershed is located in central Louisiana and is primarily composed of forested and wetland areas. Urban areas compose less than 1% of the watershed.

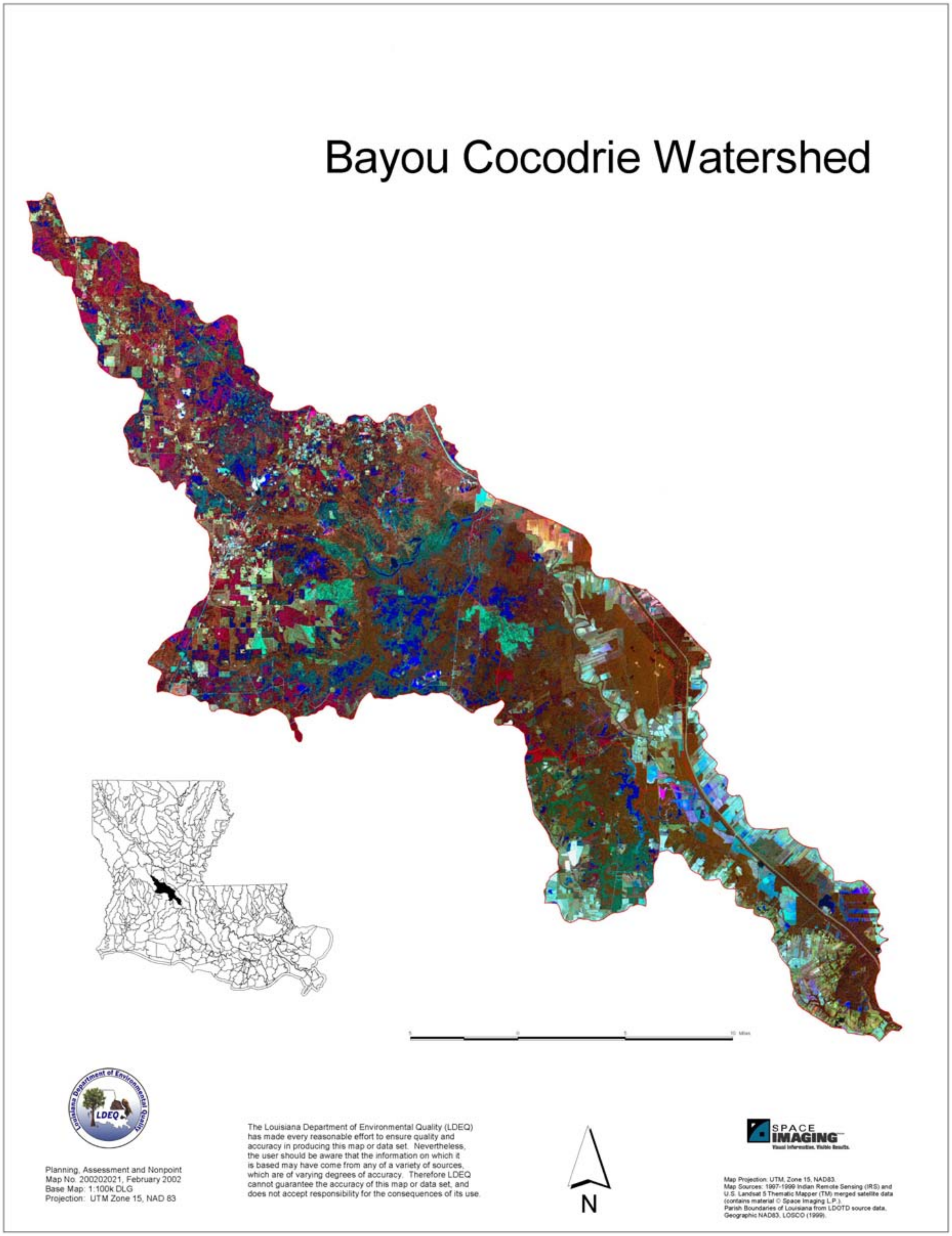



**FIGURE 1.2** The satellite imagery above shows heavily vegetative areas of forest and lakes and wetlands.

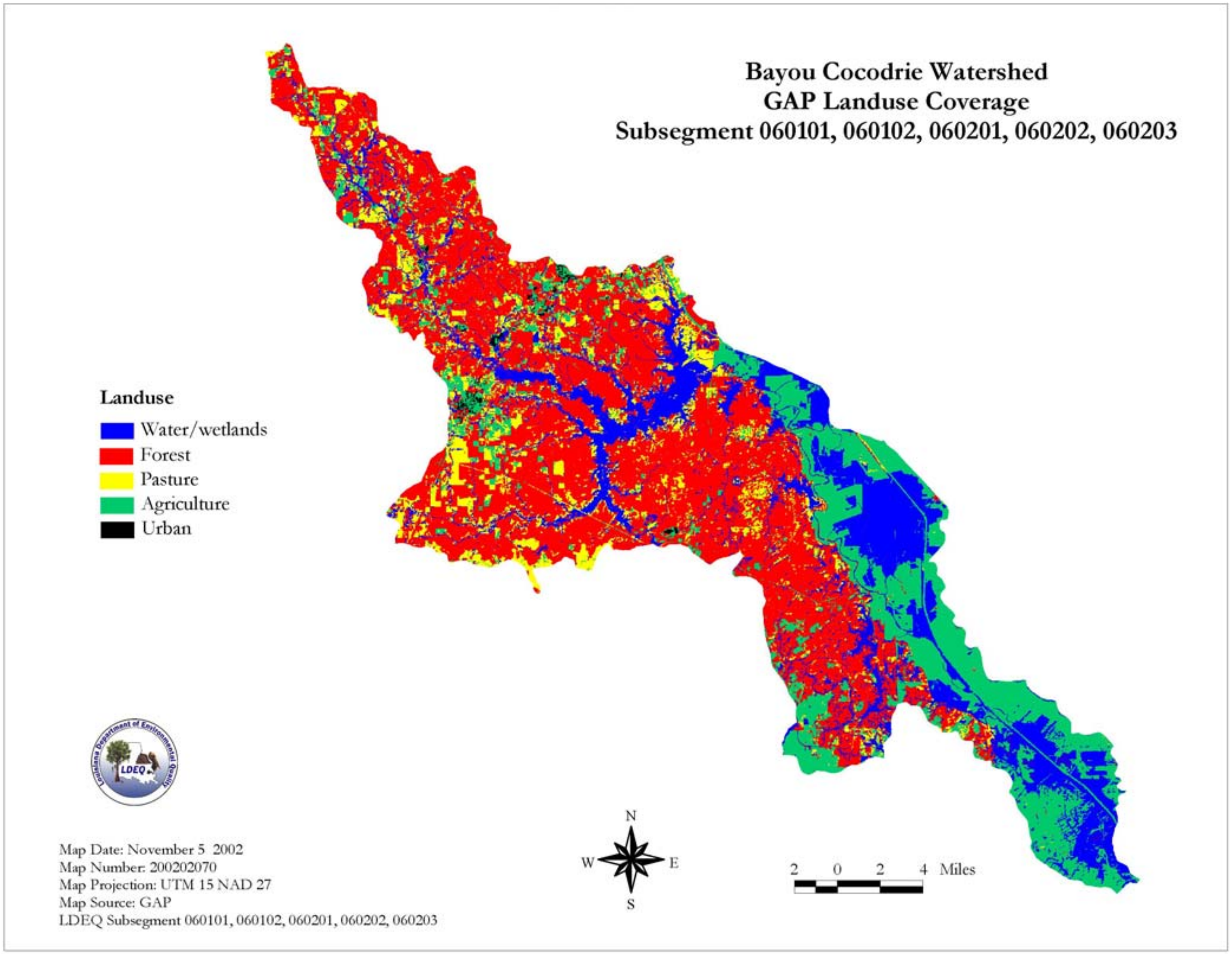



**FIGURE 1.3** As you can see above, much of the Bayou Cocodrie watershed is composed of forest and wetland to the NW and most of the agricultural crops are produced in the SE region of the watershed.

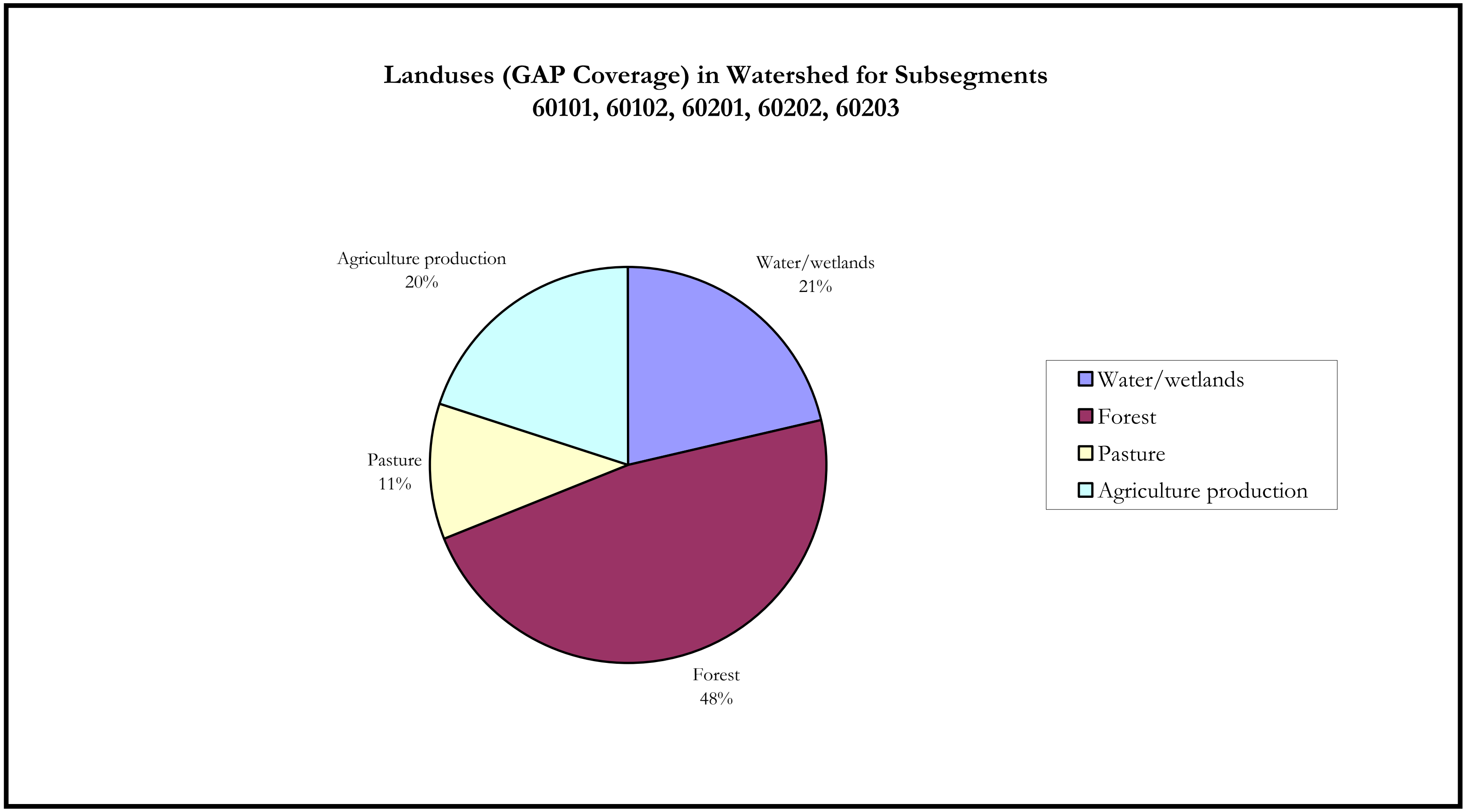



**Figure 1.4** Forested and wetland areas compose a significant amount of the landuses in the region as opposed to other watersheds in the basin.

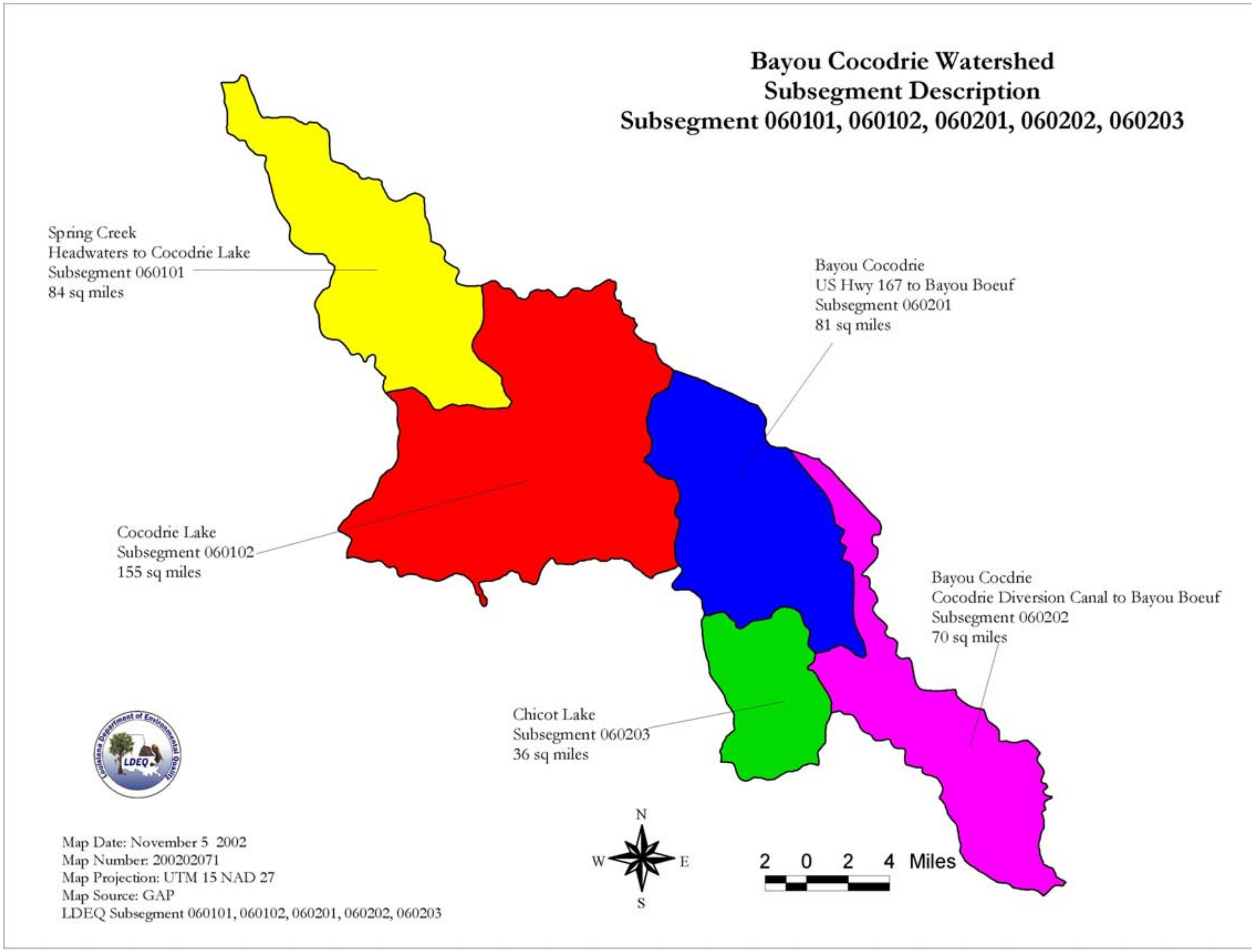



**Figure 1.5** There are 5 subsegments in the Bayou Cocodrie watershed. Each is monitored and assessed independently to determine if the waterways are meeting criteria.

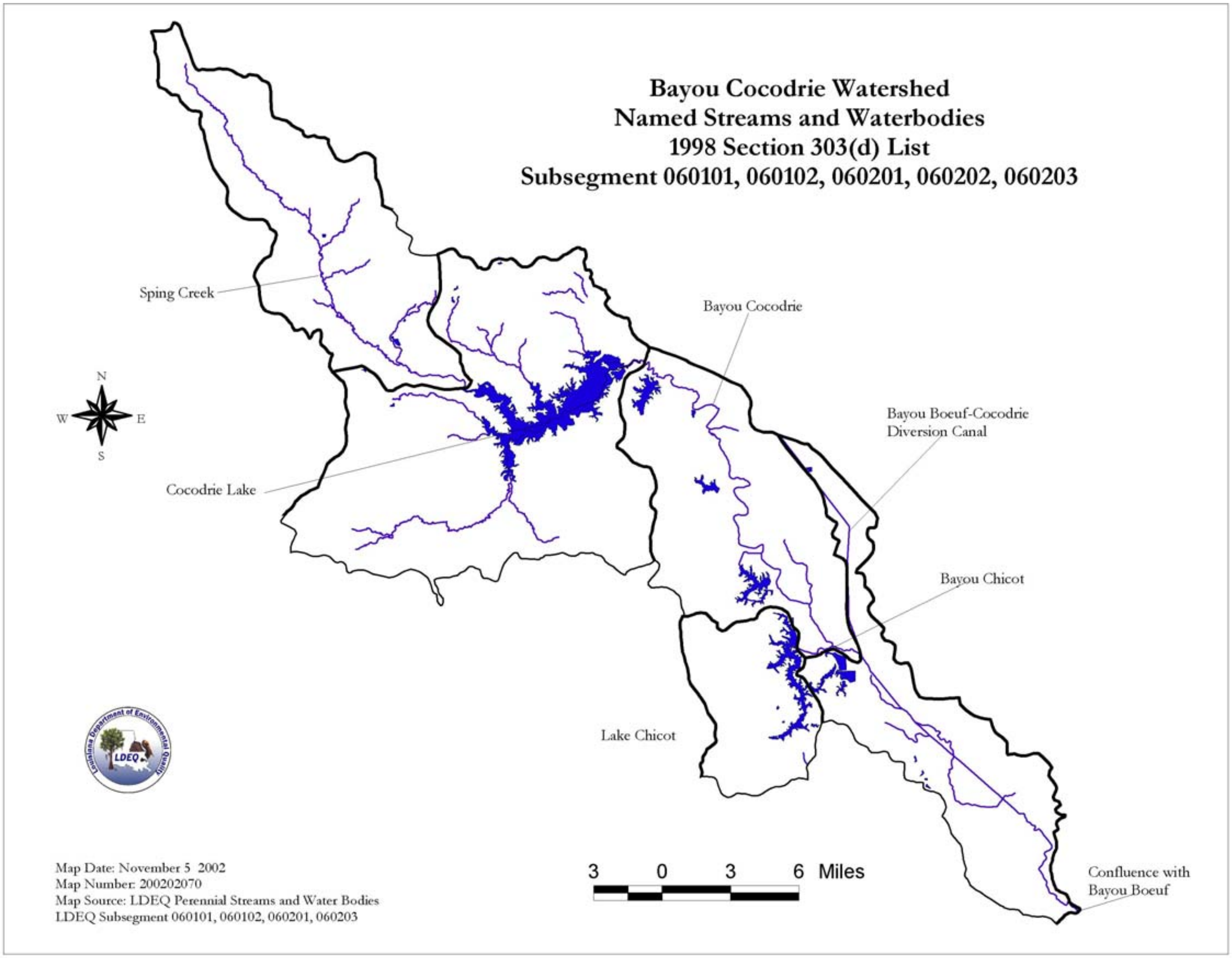



**Figure 1.6** The map above illustrates the stream network and lakes throughout the watershed. The Bayou Boeuf-Cocodrie Diversion canal intercepts Bayou Cocodrie at several points along the Southern portion of the bayou.

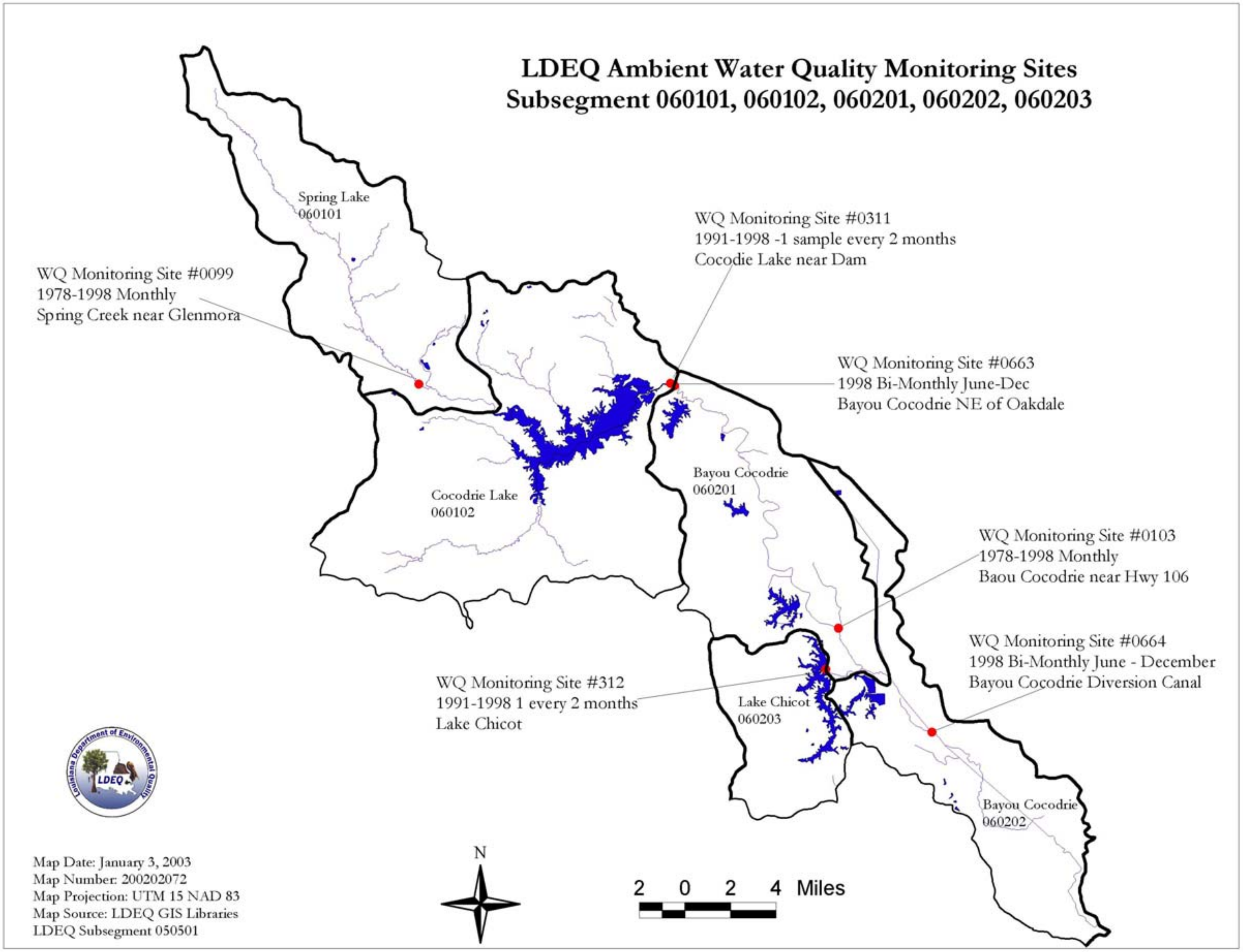
# 2.0 Historical Environmental Water Quality Monitoring in the Bayou Cocodrie Watershed

## 2.1 Introduction

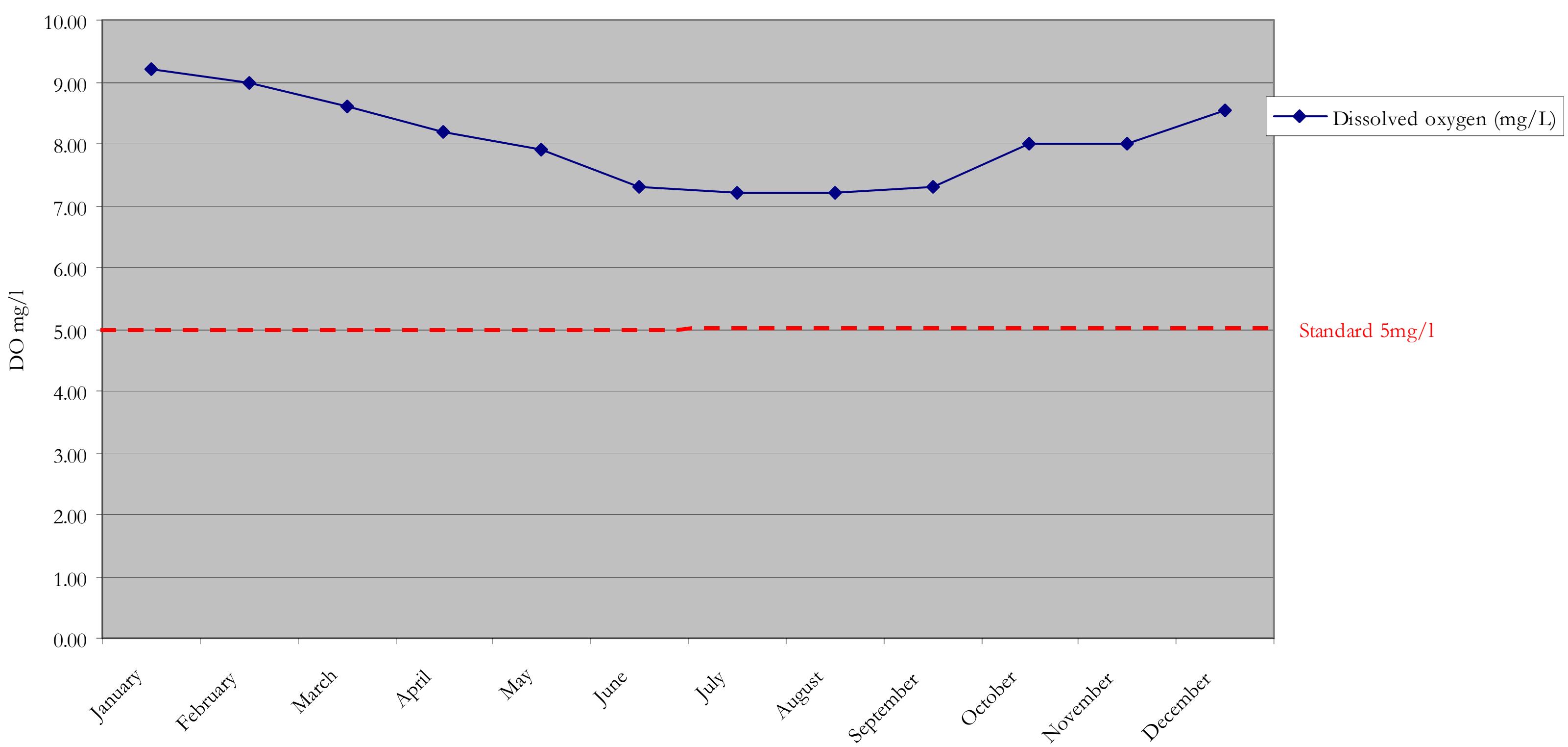
Ambient water quality data has been collected at several sites over the years in the Cocodrie watershed. The sites and the years of collections are listed in the table below. A watershed map showing the sampling station sites is shown on the following page. Streams, bayous, and lakes are included on the 303 (d) list of Impaired Waterbodies if they fail to meet standards in excess of 10% of the time. If the stream segments are on the 303 (d) list the watershed is scheduled for an implementation of a TMDL to insure that standards are maintained.

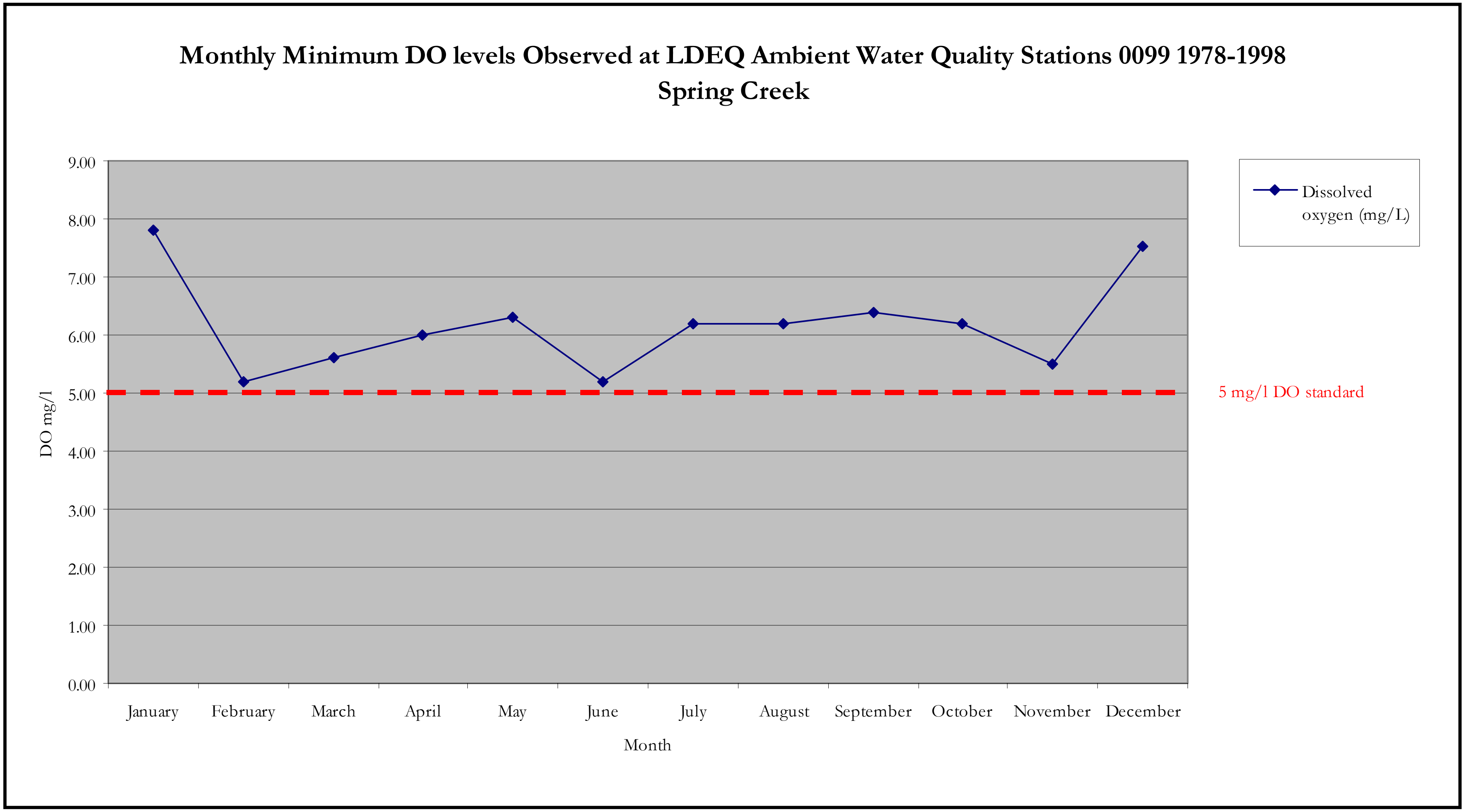
There are 6 water quality monitoring stations that have gathered data for the 5 watersheds. The results indicate that the upper segment of Spring Creek is meeting water quality standards for DO throughout the all-4 seasons. The segments to the south begin to fall below LDEQ standards for parts of the year. Subsegment 060202 is the exception, this waterbody receives additional flow from the Bayou Boeuf-Cocodie Diversion Canal. The greater flow and turbulence maintains higher $O_2$ levels even in low flow conditions.

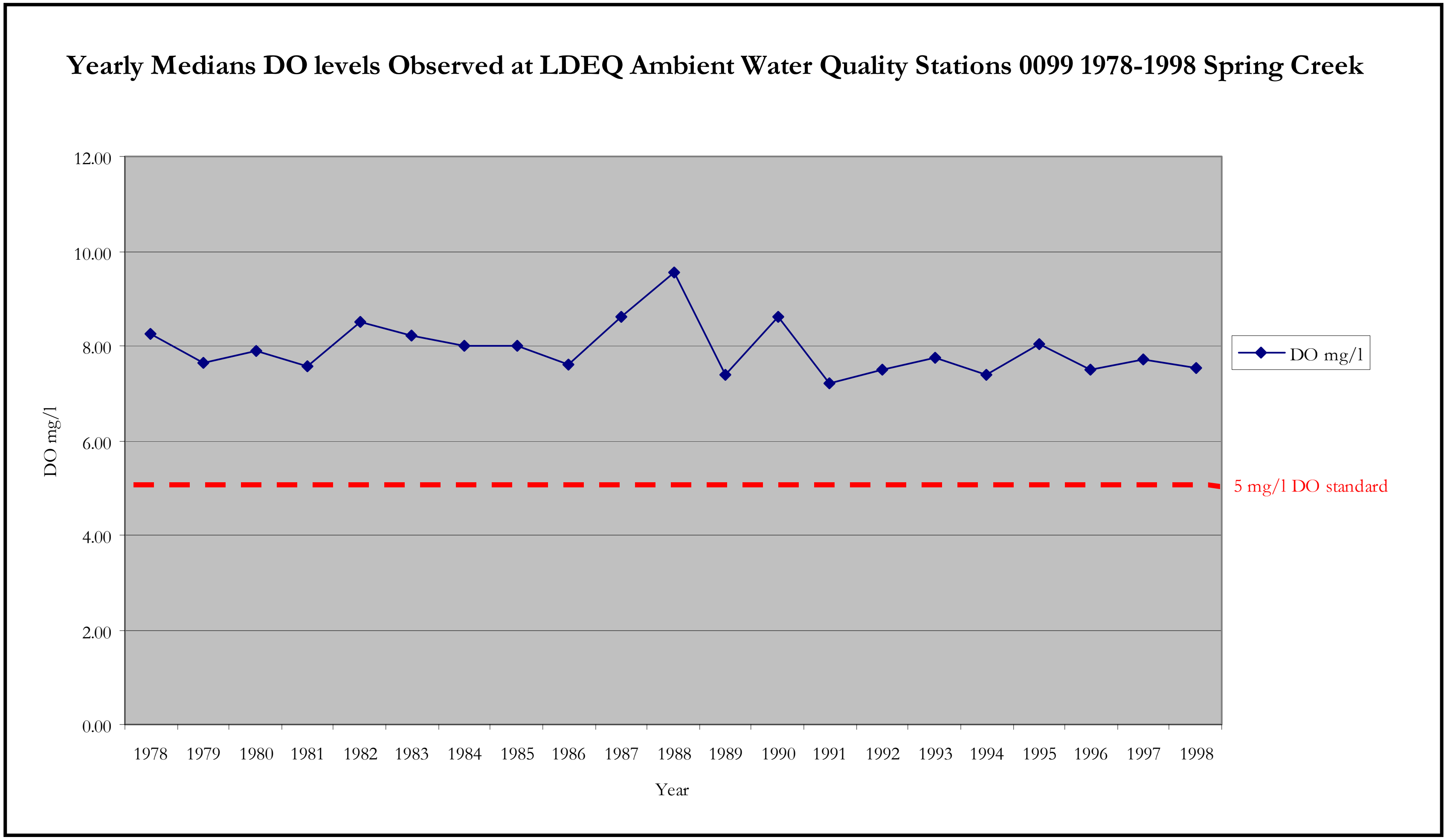
| LDEQ WQ Station # | Segment Number | Watershed Name | Duration of Sampling Data Set | Frequency of Sample | Is there a DO TMDL |
|---|---|---|---|---|---|
| 0099 | 060101 | Spring Lake | 1978-1998 | Monthly | No |
| 0103 | 060201 | Bayou Cocodrie | 1978-1998 | Monthly | Yes |
| 0311 | 060102 | Lake Cocodrie | 1991-1998 | 1 sample every 2 months* | Yes |
| 0312 | 060203 | Lake Chicot | 1991-1998 | 1 sample every 2 months* | Yes |
| 0663 | 060201 | Bayou Cocodrie | 1998 June-December | Bi-monthly | Yes |
| 0664 | 060202 | Bayou Cocodrie | 1998 June-December | Bi-monthly | No |

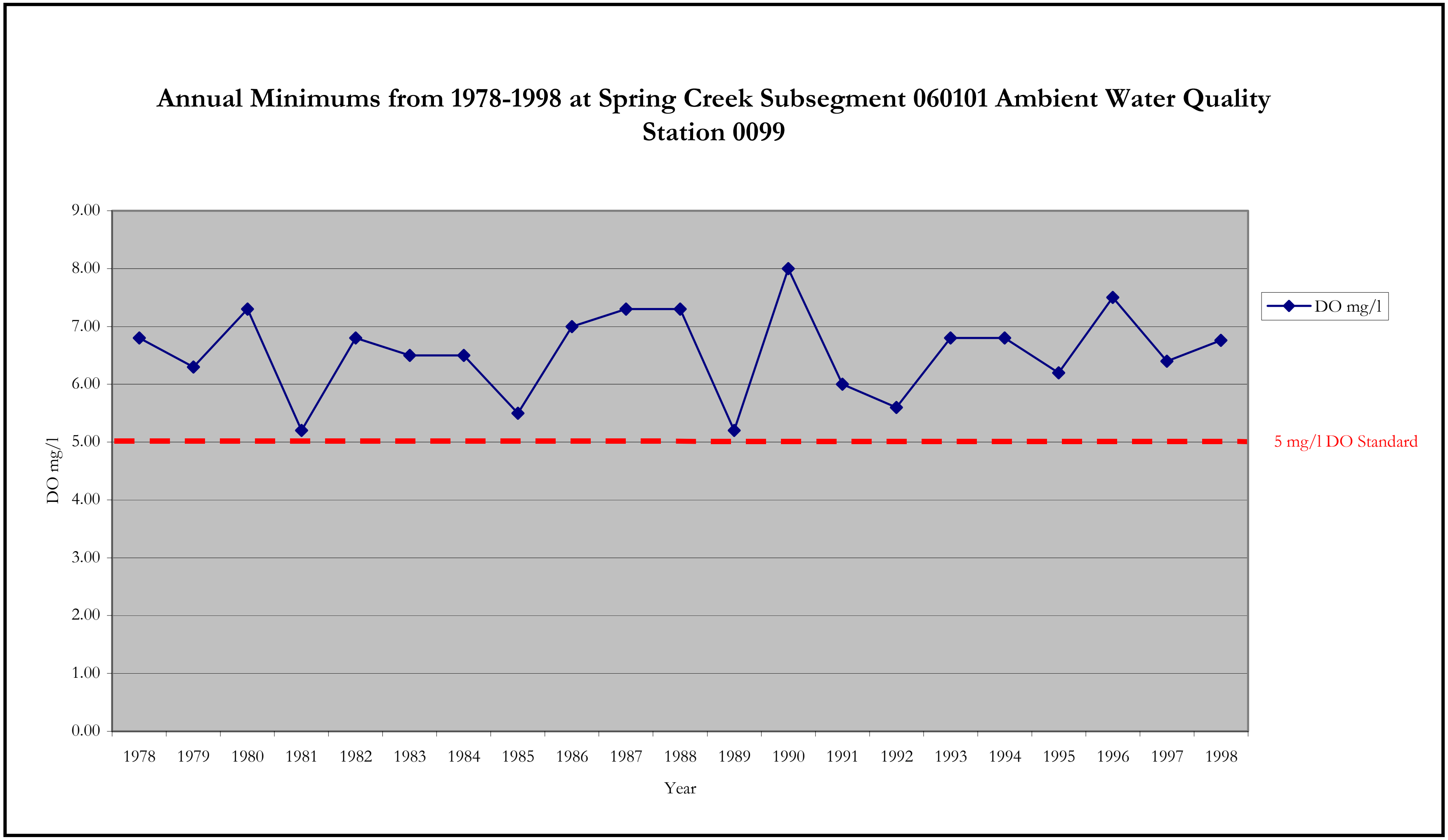

LDEQ Ambient Water Quality Monitoring Sites
Subsegment 060101, 060102, 060201, 060202, 060203
Spring Lake
060101
WQ Monitoring Site #0311
1991-1998 -1 sample every 2 months
Cocodie Lake near Dam
WQ Monitoring Site #0099
1978-1998 Monthly
Spring Creek near Glenmora
WQ Monitoring Site #0663
1998 Bi-Monthly June-Dec
Bayou Cocodrie NE of Oakdale
Bayou Cocodrie
060201
Cocodrie Lake
060102
WQ Monitoring Site #0103
1978-1998 Monthly
Baou Cocodrie near Hwy 106
WQ Monitoring Site #0664
1998 Bi-Monthly June - December
Bayou Cocodrie Diversion Canal
WQ Monitoring Site #312
1991-1998 1 every 2 months
Lake Chicot
Lake Chicot
060203
Bayou Cocodrie
060202
Map Date: January 3, 2003
Map Number: 200202072
Map Projection: UTM 15 NAD 83
Map Source: LDEQ GIS Libraries
LDEQ Subsegment 050501
N
2 0 2 4 Miles

**LDEQ Ambient Water Quality Spring Creek Station 0099 Subsegment 060101 1978-1998 Dissolved Oxygen (Monthly Medians)**




Monthly Minimum DO levels Observed at LDEQ Ambient Water Quality Stations 0099 1978-1998
Spring Creek
DO mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December
Month
Dissolved oxygen (mg/L)
5 mg/l DO standard


Yearly Medians DO levels Observed at LDEQ Ambient Water Quality Stations 0099 1978-1998 Spring Creek
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DO mg/l
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Year
DO mg/l
5 mg/l DO standard


Annual Minimums from 1978-1998 at Spring Creek Subsegment 060101 Ambient Water Quality Station 0099
DO mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Year
DO mg/l
5 mg/l DO Standard

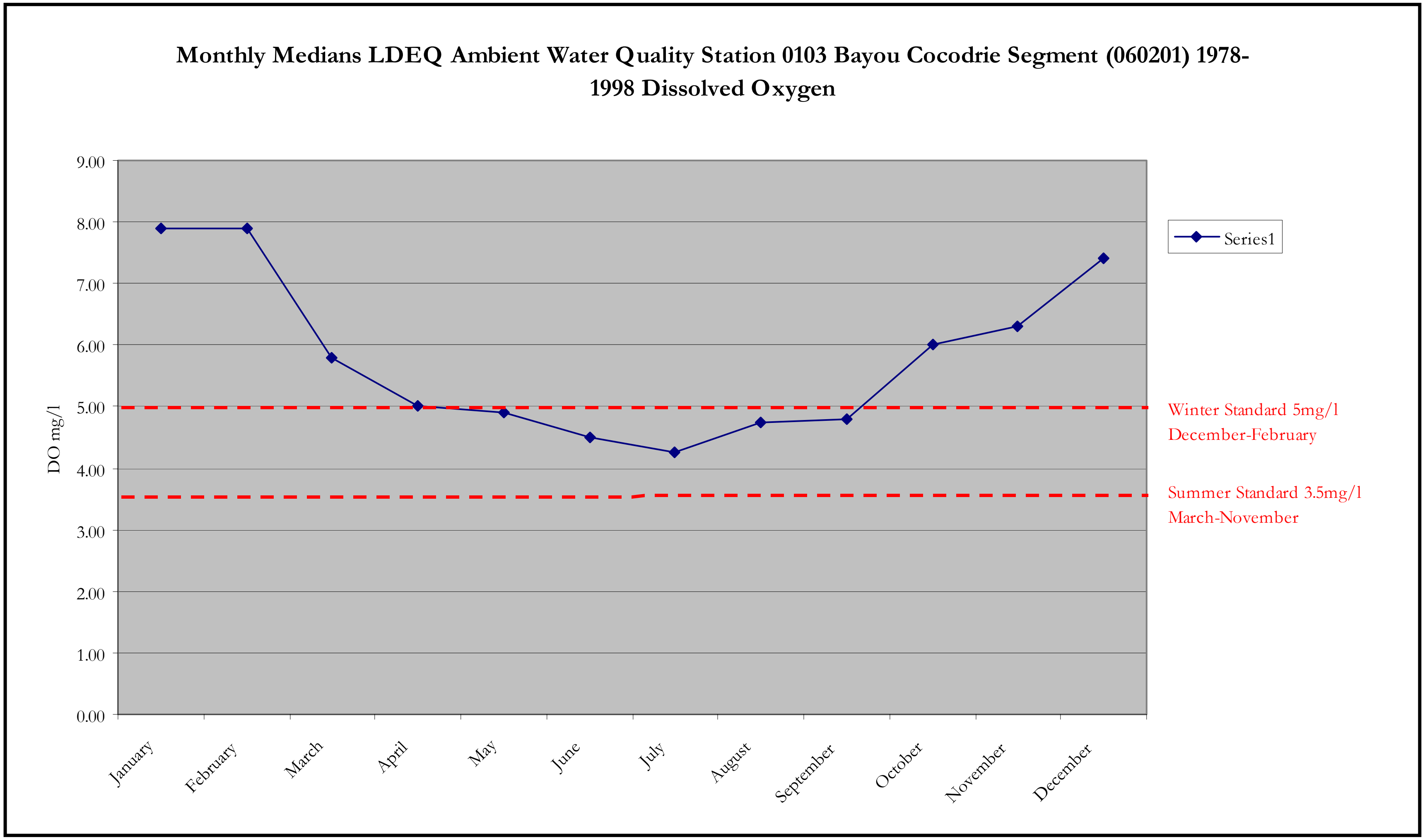
## Monthly Medians from 1978-1998 at Spring Creek Subsegment 060101 Ambient Water Quality Station 0099

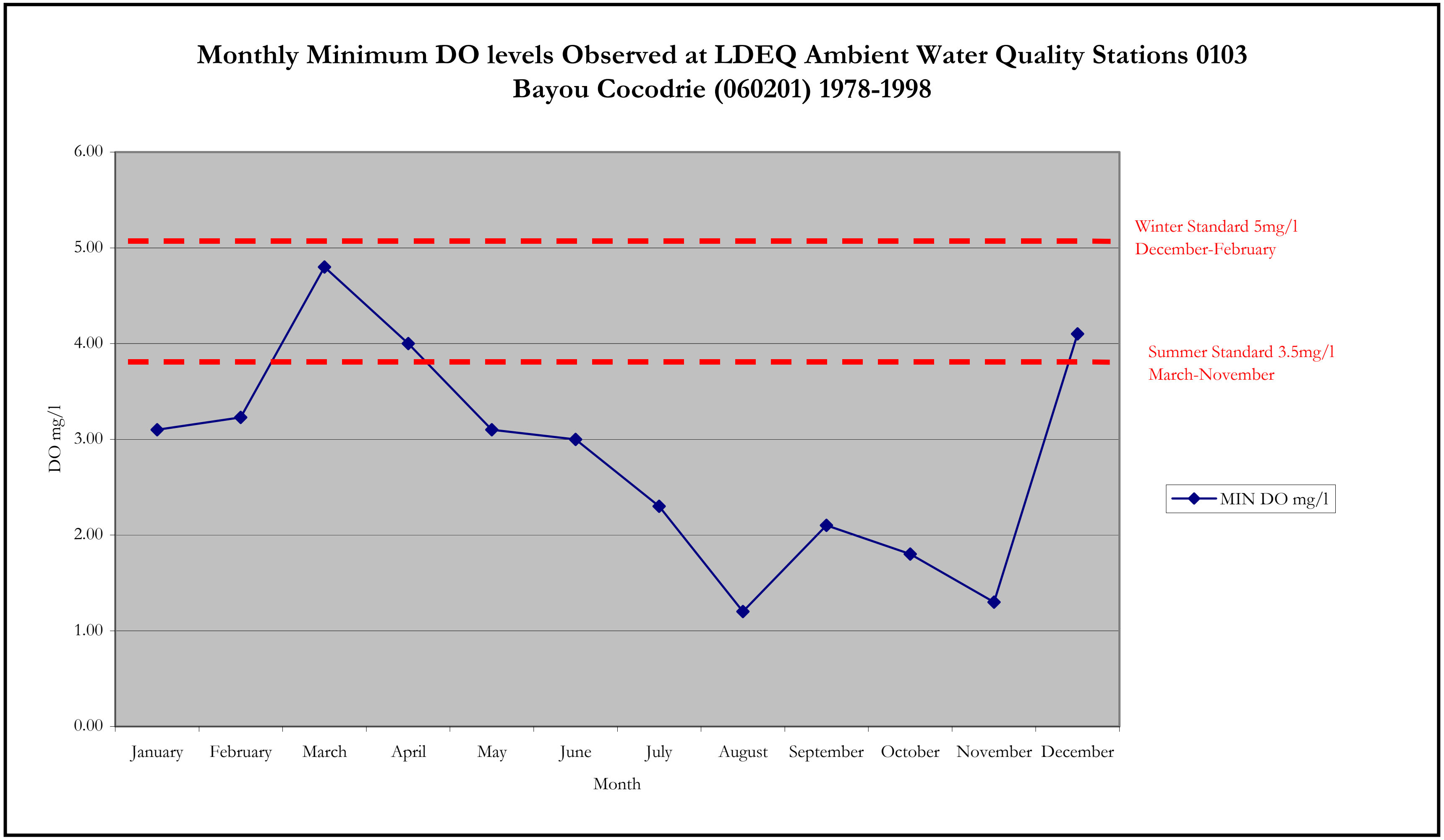
| Month | Temperature | Dissolved oxygen | Total dissolved solids | Total suspended solids | Turbidity | Total Solids | NO2 Nitrate | Total jeldahl nitrogen | Total Phosphorus | Total organic carbon |
|---|---|---|---|---|---|---|---|---|---|---|
| | Centigrade | (mg/L) | (mg/L) | (mg/L) | NTU | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| January | 12.20 | 9.20 | 66.00 | 5.00 | 10.50 | 65.00 | 0.05 | 0.42 | 0.04 | 239.00 |
| February | 13.50 | 9.00 | 83.75 | 10.00 | 12.50 | 95.00 | 0.09 | 0.36 | 0.04 | 230.50 |
| March | 15.00 | 8.60 | 76.00 | 10.50 | 13.00 | 96.00 | 0.08 | 0.44 | 0.04 | 222.00 |
| April | 17.50 | 8.20 | 56.00 | 10.75 | 11.00 | 66.00 | 0.08 | 0.37 | 0.03 | 223.00 |
| May | 20.40 | 7.90 | 64.00 | 8.50 | 11.00 | 80.00 | 0.11 | 0.42 | 0.04 | 224.00 |
| June | 22.60 | 7.30 | 67.50 | 9.50 | 9.65 | 78.00 | 0.11 | 0.36 | 0.03 | 225.00 |
| July | 23.70 | 7.20 | 60.50 | 12.00 | 7.90 | 82.00 | 0.10 | 0.42 | 0.04 | 245.00 |
| August | 23.09 | 7.22 | 62.50 | 8.00 | 8.20 | 72.00 | 0.10 | 0.37 | 0.04 | 236.50 |
| September | 22.70 | 7.30 | 68.00 | 8.50 | 6.90 | 72.00 | 0.09 | 0.29 | 0.03 | 237.50 |
| October | 18.90 | 8.00 | 55.00 | 7.00 | 6.50 | 59.00 | 0.07 | 0.38 | 0.04 | 238.50 |
| November | 17.35 | 8.00 | 78.00 | 6.00 | 6.05 | 75.00 | 0.06 | 0.43 | 0.04 | 239.50 |
| December | 13.61 | 8.60 | 63.00 | 6.50 | 5.25 | 68.00 | 0.03 | 0.32 | 0.03 | 2.60 |
| Criteria | | 3mg/l summer<br>5mg/l winter | 260 mg/l | NA | 150 NTU | | Naturally occurring range [1] | | | NA |

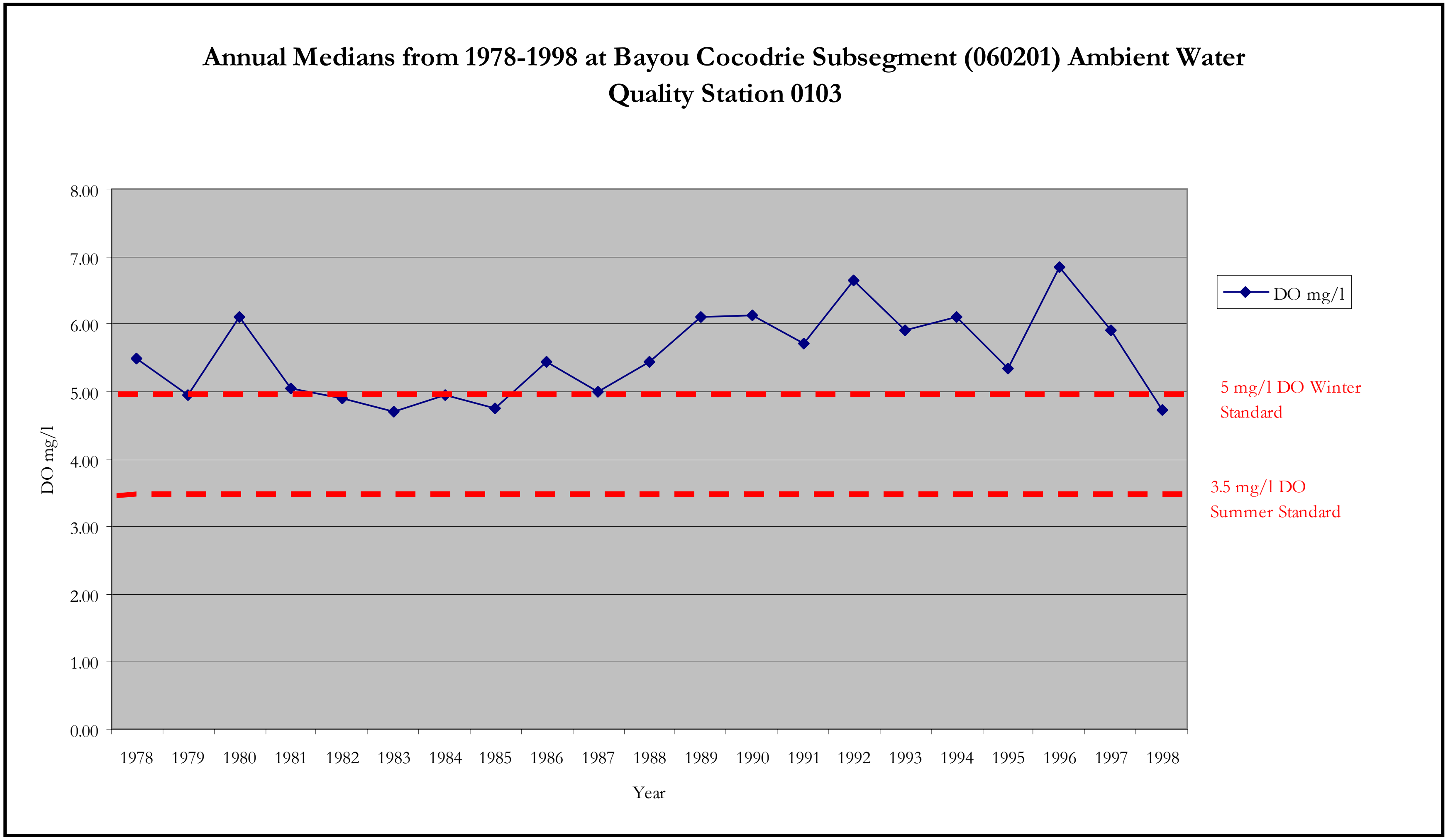
[1] The naturally occurring range of nitrogen-phosphorus ratios shall be maintained. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated uses shall not be added to any surface waters. LAC 33:IX.1113.8

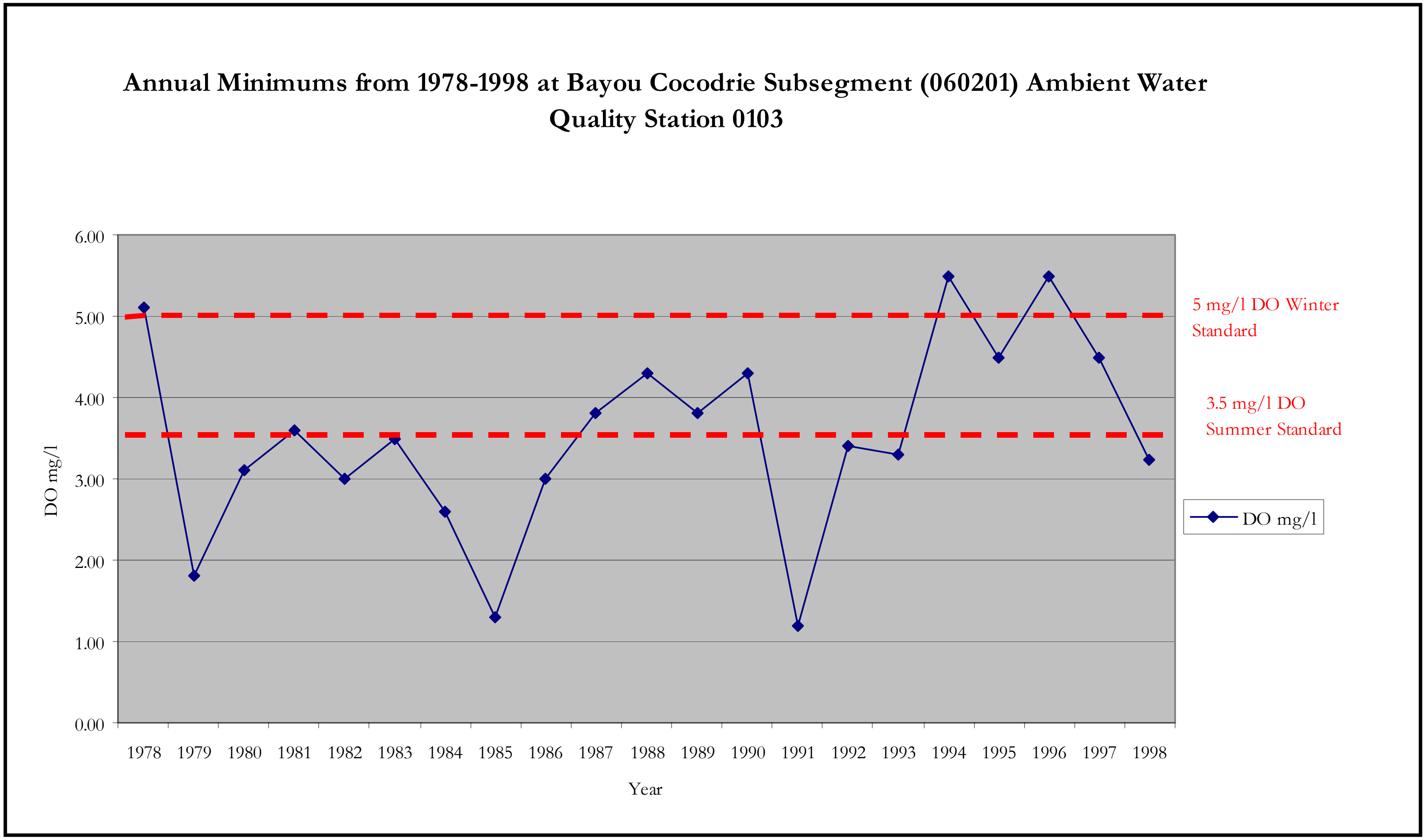
## Annual Medians from 1978-1998 at Spring Creek Subsegment 060101 Ambient Water Quality Station 0099

| YEAR | Temperature<br>Centigrade | Dissolved oxygen<br>(mg/L) | Total dissolved solids<br>(mg/L) | Total suspended solids<br>(mg/L) | Turbidity<br>NTU | Total Solids<br>(mg/l) | NO2 Nitrate<br>(mg/L) | Total Kjeldahl nitrogen<br>(mg/L) | Total Phosphorus<br>(mg/L) | Total organic carbon<br>(mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | 19.25 | 8.25 | 71.00 | 11.00 | 8.35 | 73.00 | 0.10 | 0.20 | 0.03 | 10.00 |
| 1979 | 18.50 | 7.65 | 82.00 | 10.00 | 11.00 | 92.00 | 0.09 | 0.20 | 0.03 | 7.10 |
| 1980 | 15.00 | 7.90 | 60.00 | 9.00 | 10.00 | 74.00 | 0.08 | 0.32 | 0.03 | 7.15 |
| 1981 | 18.50 | 7.55 | 64.00 | 8.00 | 4.50 | 68.00 | 0.05 | 0.25 | 0.02 | 7.55 |
| 1982 | 18.40 | 8.50 | 54.00 | 6.00 | 4.30 | 62.00 | 0.07 | 0.31 | 0.03 | 8.40 |
| 1983 | 17.20 | 8.20 | 66.00 | 9.50 | 9.95 | 76.00 | 0.07 | 0.27 | 0.03 | 8.75 |
| 1984 | 19.35 | 8.00 | 54.00 | 12.00 | 13.00 | 70.00 | 0.09 | 0.33 | 0.04 | 8.50 |
| 1985 | 20.20 | 8.00 | 61.00 | 6.00 | 6.75 | 66.00 | 0.08 | 0.40 | 0.04 | 7.30 |
| 1986 | 21.25 | 7.60 | 58.00 | 11.00 | 6.35 | 70.00 | 0.08 | 0.44 | 0.05 | 7.35 |
| 1987 | 17.90 | 8.60 | 53.50 | 10.50 | 9.90 | 69.00 | 0.05 | 0.64 | 0.06 | 2.60 |
| 1988 | 18.45 | 9.55 | 63.00 | 10.00 | 10.00 | 78.00 | 0.10 | 0.34 | 0.03 | 1.75 |
| 1989 | 19.65 | 7.40 | 78.50 | 12.50 | 11.00 | 91.00 | 0.10 | 0.48 | 0.04 | 2.10 |
| 1990 | 20.70 | 8.60 | 59.00 | 6.00 | 6.50 | 66.00 | 0.09 | 0.39 | 0.03 | 1.50 |
| 1991 | 19.55 | 7.20 | 75.00 | 8.00 | 10.40 | 108.00 | 0.11 | 0.42 | 0.05 | 2.65 |
| 1992 | 18.10 | 7.50 | 92.00 | 8.50 | 10.50 | #NUM! | 0.10 | 0.30 | 0.04 | 2.00 |
| 1993 | 19.10 | 7.75 | 68.00 | 7.75 | 9.50 | #NUM! | 0.09 | 0.40 | 0.04 | 3.65 |
| 1994 | 18.20 | 7.40 | 73.00 | 6.00 | 9.10 | #NUM! | 0.06 | 0.52 | 0.03 | 2.95 |
| 1995 | 15.65 | 8.05 | 77.00 | 8.50 | 11.00 | #NUM! | 0.07 | 0.55 | 0.05 | 2.70 |
| 1996 | 18.45 | 7.50 | 66.00 | 6.50 | 6.00 | #NUM! | 0.06 | 0.71 | 0.06 | 4.45 |
| 1997 | 18.95 | 7.70 | 78.00 | 8.50 | 9.00 | #NUM! | 0.15 | 0.28 | 0.06 | 4.00 |
| 1998 | 20.51 | 7.54 | 74.65 | 11.00 | 8.20 | #NUM! | 0.16 | 0.54 | 0.07 | 7.30 |
| **20 yr avg** | **18.71** | **7.93** | **67.98** | **8.87** | **8.82** | **#NUM!** | **0.09** | **0.39** | **0.0** | **5.2** |
| Criteria | 3mg/l summer<br>5mg/l winter | 260 mg/l | NA | | Naturally occurring range [1] | | NA | 150 NTU | 200 cfu primary<br>1000 cfu secondary | |


Monthly Medians LDEQ Ambient Water Quality Station 0103 Bayou Cocodrie Segment (060201) 1978-1998 Dissolved Oxygen
DO mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December
Series1
Winter Standard 5mg/l
December-February
Summer Standard 3.5mg/l
March-November


Monthly Minimum DO levels Observed at LDEQ Ambient Water Quality Stations 0103
Bayou Cocodrie (060201) 1978-1998
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DO mg/l
Winter Standard 5mg/l
December-February
Summer Standard 3.5mg/l
March-November
MIN DO mg/l
January
February
March
April
May
June
July
August
September
October
November
December
Month


Annual Medians from 1978-1998 at Bayou Cocodrie Subsegment (060201) Ambient Water Quality Station 0103
DO mg/l
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Year
DO mg/l
5 mg/l DO Winter Standard
3.5 mg/l DO Summer Standard


Annual Minimums from 1978-1998 at Bayou Cocodrie Subsegment (060201) Ambient Water Quality Station 0103
DO mg/l
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Year
5 mg/l DO Winter Standard
3.5 mg/l DO Summer Standard
DO mg/l

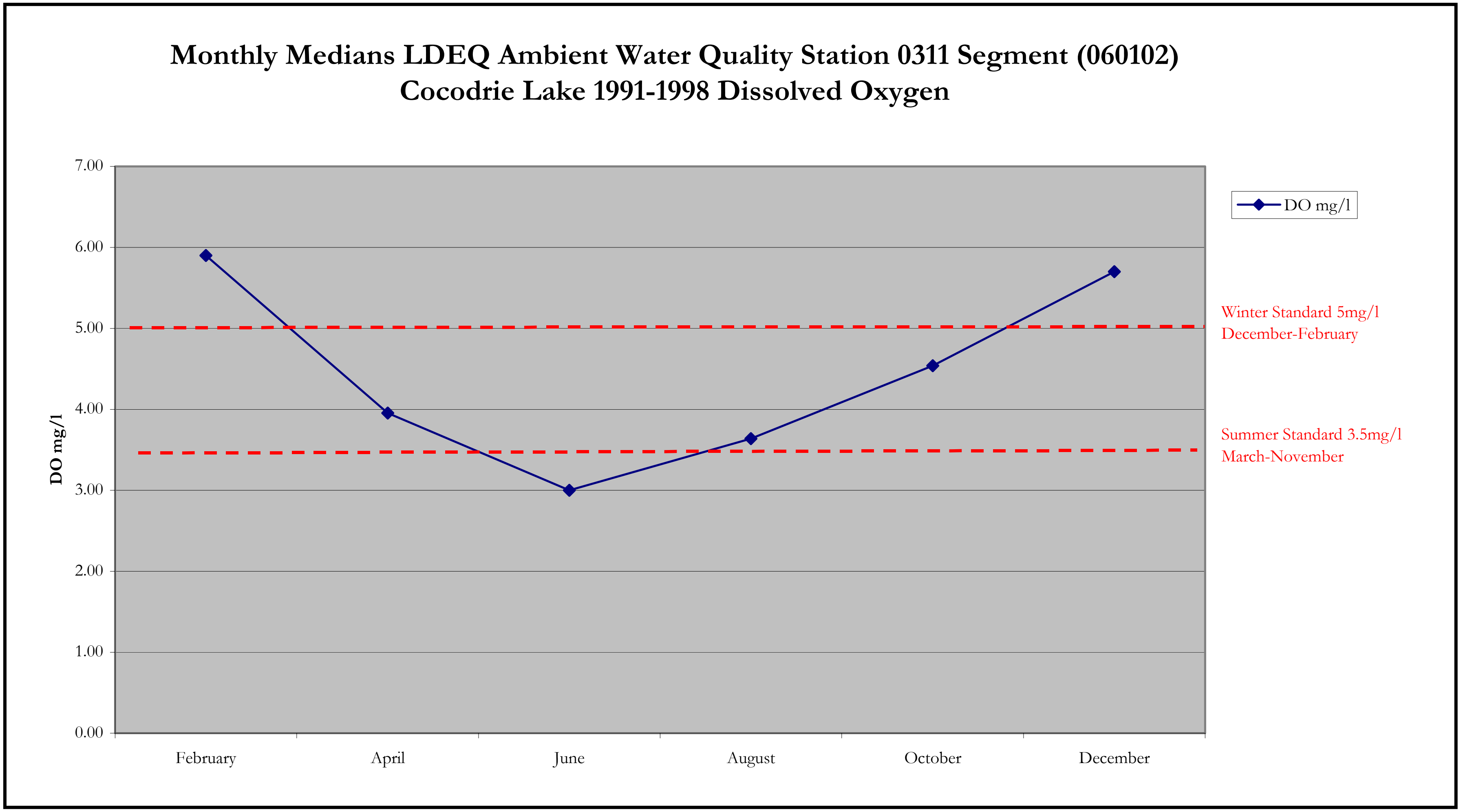
# Monthly Minimum DO levels Observed at LDEQ Ambient Water Quality Stations 0103 Bayou Cocodrie (060201) 1978-1998

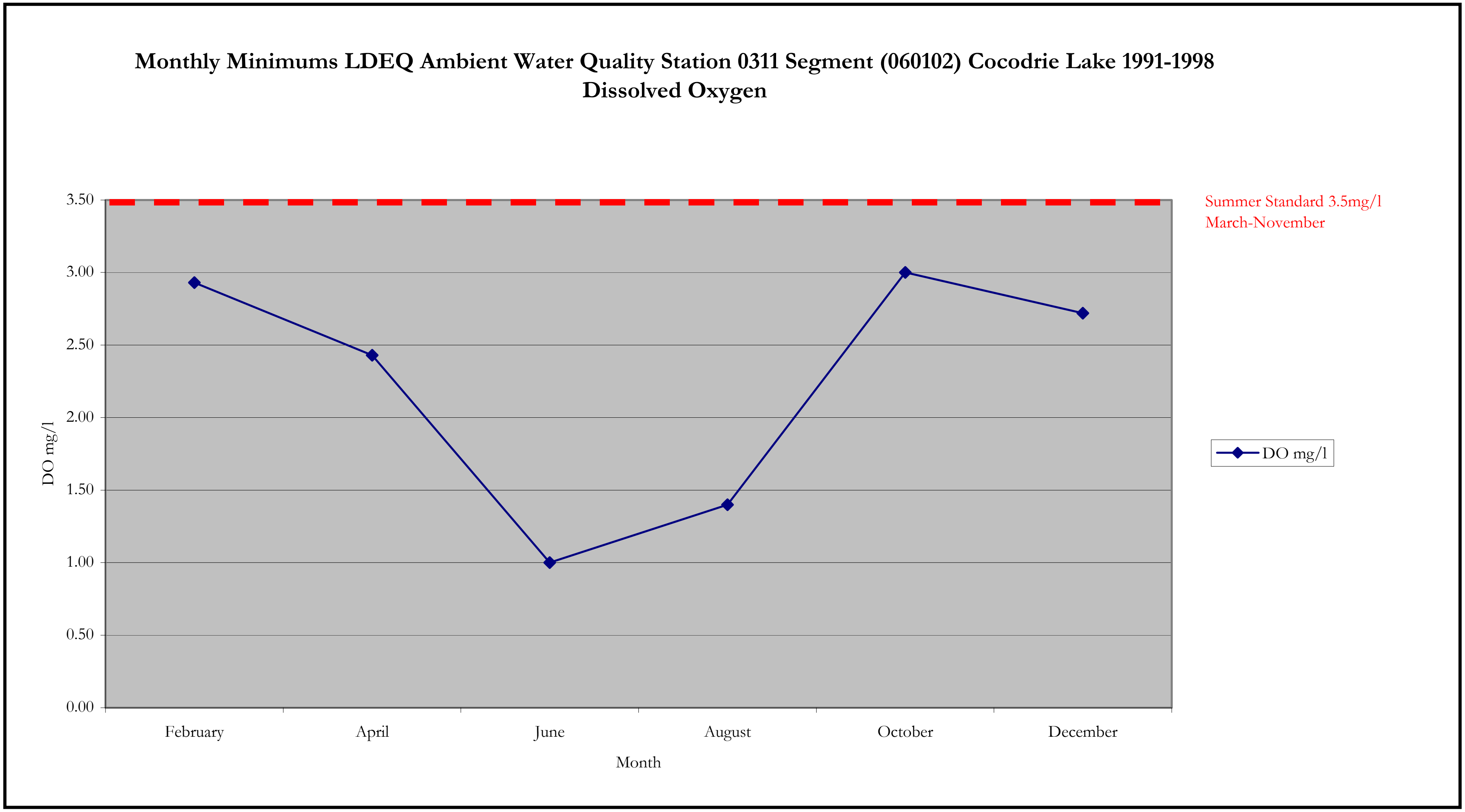
| Month | Temperature | Dissolved oxygen | Total dissolved solids | Total suspended solids | Turbidity | NO2 Nitrate | Total Kjeldahl nitrogen | Total Phosphorus | Total organic carbon |
|---|---|---|---|---|---|---|---|---|---|
| | Centigrade | (mg/L) | (mg/L) | (mg/L) | NTU | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| January | 9.05 | 7.90 | 88.00 | 12.00 | 26.50 | 0.04 | 0.59 | 0.08 | 8.85 |
| February | 11.75 | 7.90 | 100.00 | 12.00 | 25.00 | 0.03 | 0.62 | 0.07 | 9.30 |
| March | 15.70 | 5.80 | 81.00 | 11.00 | 25.00 | 0.02 | 0.70 | 0.06 | 8.70 |
| April | 18.90 | 5.00 | 80.00 | 18.00 | 18.00 | 0.05 | 0.76 | 0.08 | 8.05 |
| May | 24.00 | 4.90 | 78.00 | 24.00 | 18.50 | 0.05 | 0.75 | 0.09 | 7.10 |
| June | 26.75 | 4.49 | 80.00 | 17.00 | 13.00 | 0.05 | 0.72 | 0.09 | 7.50 |
| July | 28.55 | 4.25 | 74.00 | 14.00 | 20.00 | 0.07 | 0.62 | 0.10 | 6.20 |
| August | 28.65 | 4.75 | 72.00 | 18.00 | 12.00 | 0.06 | 0.54 | 0.08 | 6.50 |
| September | 27.00 | 4.80 | 64.00 | 14.00 | 14.00 | 0.05 | 0.55 | 0.08 | 5.20 |
| October | 21.00 | 6.00 | 83.95 | 10.00 | 10.00 | 0.04 | 0.56 | 0.07 | 6.55 |
| November | 17.25 | 6.30 | 74.00 | 9.00 | 8.70 | 0.03 | 0.52 | 0.06 | 5.70 |
| December | 12.20 | 7.40 | 80.00 | 10.00 | 17.50 | 0.03 | 0.56 | 0.08 | 10.40 |
| Criteria | | 3mg/l summer<br>5mg/l winter | 260 mg/l | NA | 150 NTU | Naturally occurring range [1] | | | NA |

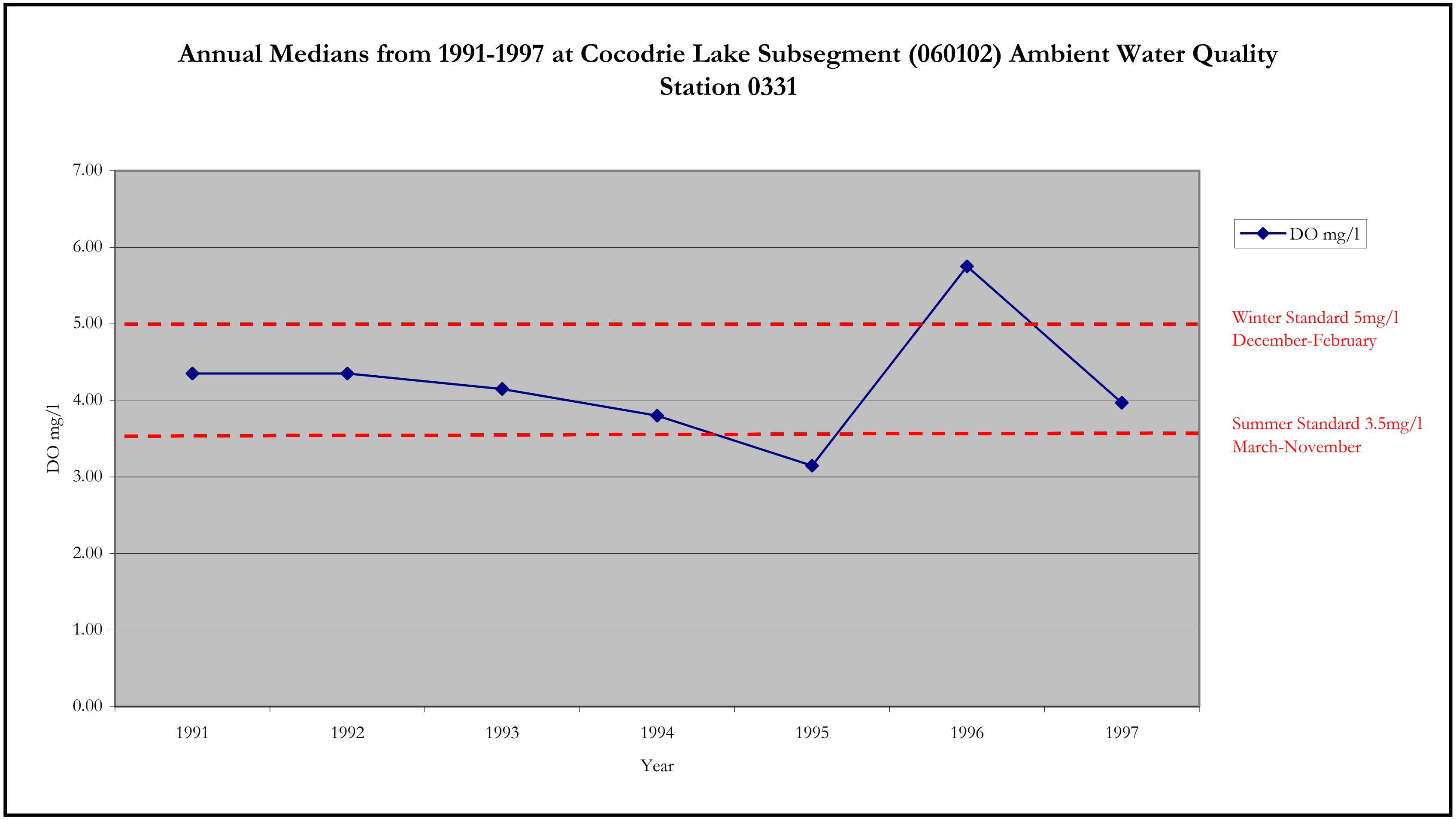
[1] The naturally occurring range of nitrogen-phosphorus ratios shall be maintained. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated uses shall not be added to any surface waters. LAC 33:IX.1113.8

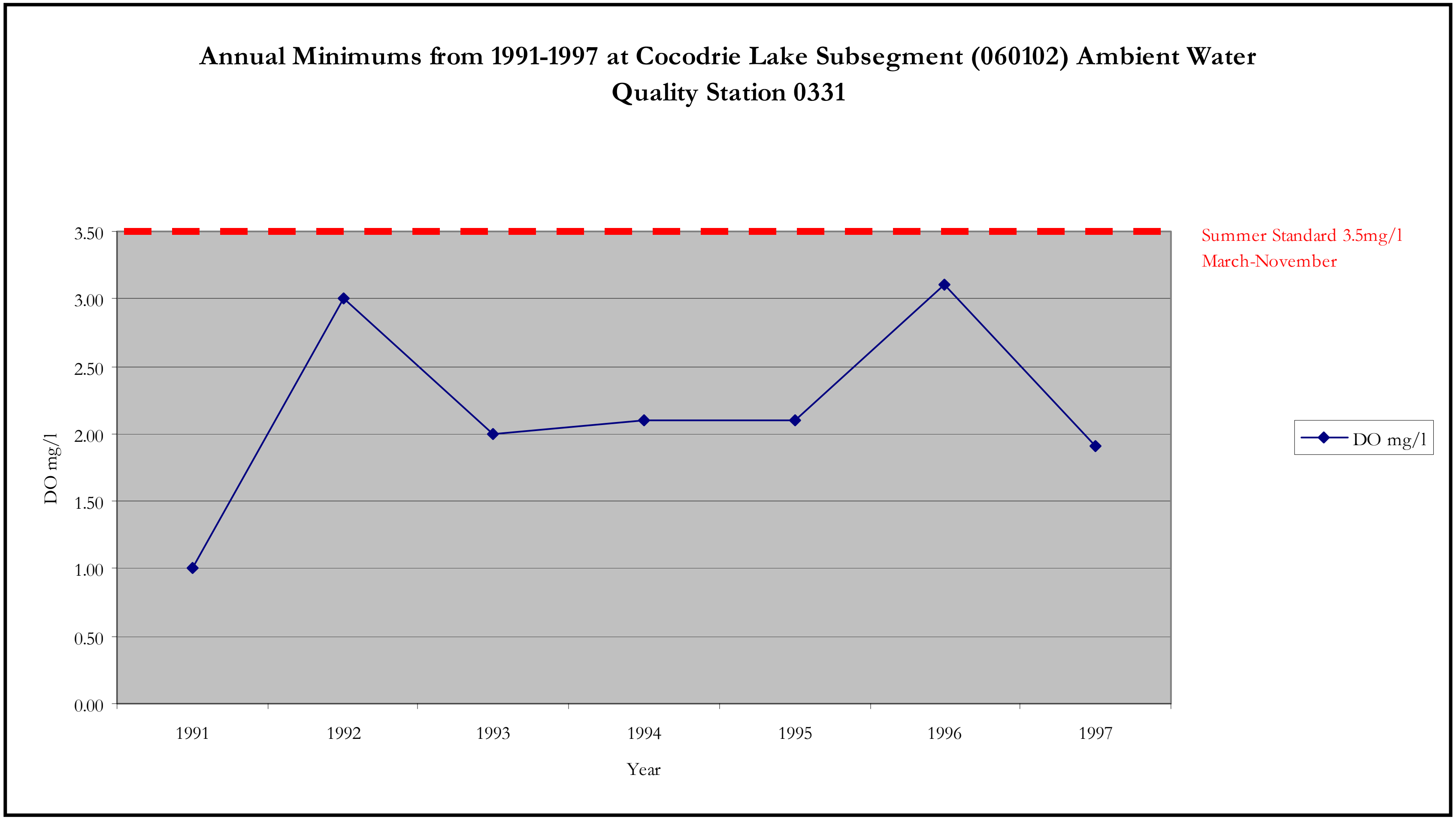
# Annual Medians from 1978-1998 at Bayou Cocodrie Subsegment (060201) Ambient Water Quality Station 0103

| YEAR | Temp<br>Centigrade | Dissolved oxygen<br>(mg/L) | Total dissolved solids<br>(mg/L) | Total suspended solids<br>(mg/L) | Turbidity<br>NTU | Total Solids<br>(mg/l) | NO2 Nitrate<br>(mg/L) | Total Kjeldahl nitrogen<br>(mg/L) | Total Phosphorus<br>(mg/L) | Total organic carbon<br>(mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | 23.75 | 5.50 | 79.00 | 23.00 | 20.00 | 0.05 | 0.38 | 0.06 | 10.25 | 0.00 |
| 1979 | 22.00 | 4.95 | 112.00 | 12.00 | 21.00 | 0.06 | 0.47 | 0.08 | 9.00 | 0.00 |
| 1980 | 18.50 | 6.10 | 70.00 | 34.00 | 19.00 | 0.04 | 0.35 | 0.08 | 4.50 | 0.00 |
| 1981 | 26.75 | 5.05 | 86.00 | 20.00 | 16.00 | 0.06 | 0.54 | 0.07 | 7.00 | 0.00 |
| 1982 | 20.50 | 4.90 | 85.00 | 14.00 | 17.50 | 0.05 | 0.76 | 0.07 | 8.90 | 0.00 |
| 1983 | 19.20 | 4.70 | 79.00 | 7.00 | 22.00 | 0.03 | 0.71 | 0.07 | 6.85 | 0.00 |
| 1984 | 21.25 | 4.95 | 72.00 | 14.00 | 26.00 | 0.04 | 0.79 | 0.13 | 8.10 | 0.00 |
| 1985 | 22.95 | 4.75 | 73.00 | 14.50 | 17.00 | 0.06 | 0.83 | 0.13 | 7.85 | 0.00 |
| 1986 | 22.00 | 5.45 | 68.00 | 13.00 | 15.50 | 0.05 | 0.85 | 0.10 | 7.90 | 0.00 |
| 1987 | 19.05 | 5.00 | 71.00 | 12.00 | 18.00 | 0.02 | 1.01 | 0.10 | 7.65 | 0.00 |
| 1988 | 20.25 | 5.45 | 78.00 | 18.00 | 21.50 | 0.05 | 0.63 | 0.07 | 7.20 | 0.00 |
| 1989 | 19.55 | 6.10 | 80.00 | 17.50 | 16.00 | 0.06 | 0.65 | 0.10 | 7.65 | 0.00 |
| 1990 | 19.54 | 6.12 | 81.00 | 15.00 | 12.00 | 0.04 | 0.54 | 0.06 | 5.05 | 0.00 |
| 1991 | 20.88 | 5.70 | 118.00 | 13.50 | 20.50 | 0.03 | 0.74 | 0.09 | 9.90 | 0.00 |
| 1992 | 18.40 | 6.65 | 109.00 | 13.00 | 14.50 | 0.03 | 0.49 | 0.06 | 7.05 | 0.00 |
| 1993 | 20.30 | 5.90 | 91.00 | 13.00 | 15.50 | 0.04 | 0.51 | 0.07 | 9.15 | 0.00 |
| 1994 | 20.50 | 6.10 | 75.00 | 17.50 | 15.00 | 0.02 | 0.54 | 0.06 | 8.75 | 0.00 |
| 1995 | 19.80 | 5.35 | 70.05 | 16.50 | 13.50 | 0.04 | 0.61 | 0.08 | 9.40 | 0.00 |
| 1996 | 17.95 | 6.85 | 81.95 | 9.00 | 7.10 | 0.03 | 0.68 | 0.08 | 9.20 | 0.00 |
| 1997 | 20.01 | 5.92 | 102.00 | 11.75 | 20.00 | 0.05 | 0.64 | 0.09 | 8.30 | 0.00 |
| 1998 | 25.42 | 4.73 | 77.05 | 15.00 | 11.00 | 0.07 | 0.78 | 0.08 | 17.10 | 0.00 |
| **20 yr avg** | **20.88** | **5.53** | **83.72** | **15.39** | **17.08** | **0.04** | **0.64** | **0.08** | **8.4** | **0.0** |
| Criteria | 3mg/l summer<br>5mg/l winter | 260 mg/l | NA | | Naturally occurring range [1] | | NA | 150 NTU | 200 cfu primary<br>1000 cfu secondary | |


Monthly Medians LDEQ Ambient Water Quality Station 0311 Segment (060102)
Cocodrie Lake 1991-1998 Dissolved Oxygen
DO mg/l
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
February
April
June
August
October
December
DO mg/l
Winter Standard 5mg/l
December-February
Summer Standard 3.5mg/l
March-November


Monthly Minimums LDEQ Ambient Water Quality Station 0311 Segment (060102) Cocodrie Lake 1991-1998
Dissolved Oxygen
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
DO mg/l
February
April
June
August
October
December
Month
Summer Standard 3.5mg/l
March-November
DO mg/l


Annual Medians from 1991-1997 at Cocodrie Lake Subsegment (060102) Ambient Water Quality Station 0331
DO mg/l
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1991
1992
1993
1994
1995
1996
1997
Year
DO mg/l
Winter Standard 5mg/l
December-February
Summer Standard 3.5mg/l
March-November


Annual Minimums from 1991-1997 at Cocodrie Lake Subsegment (060102) Ambient Water Quality Station 0331
Summer Standard 3.5mg/l
March-November
DO mg/l
DO mg/l
Year
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
1991
1992
1993
1994
1995
1996
1997

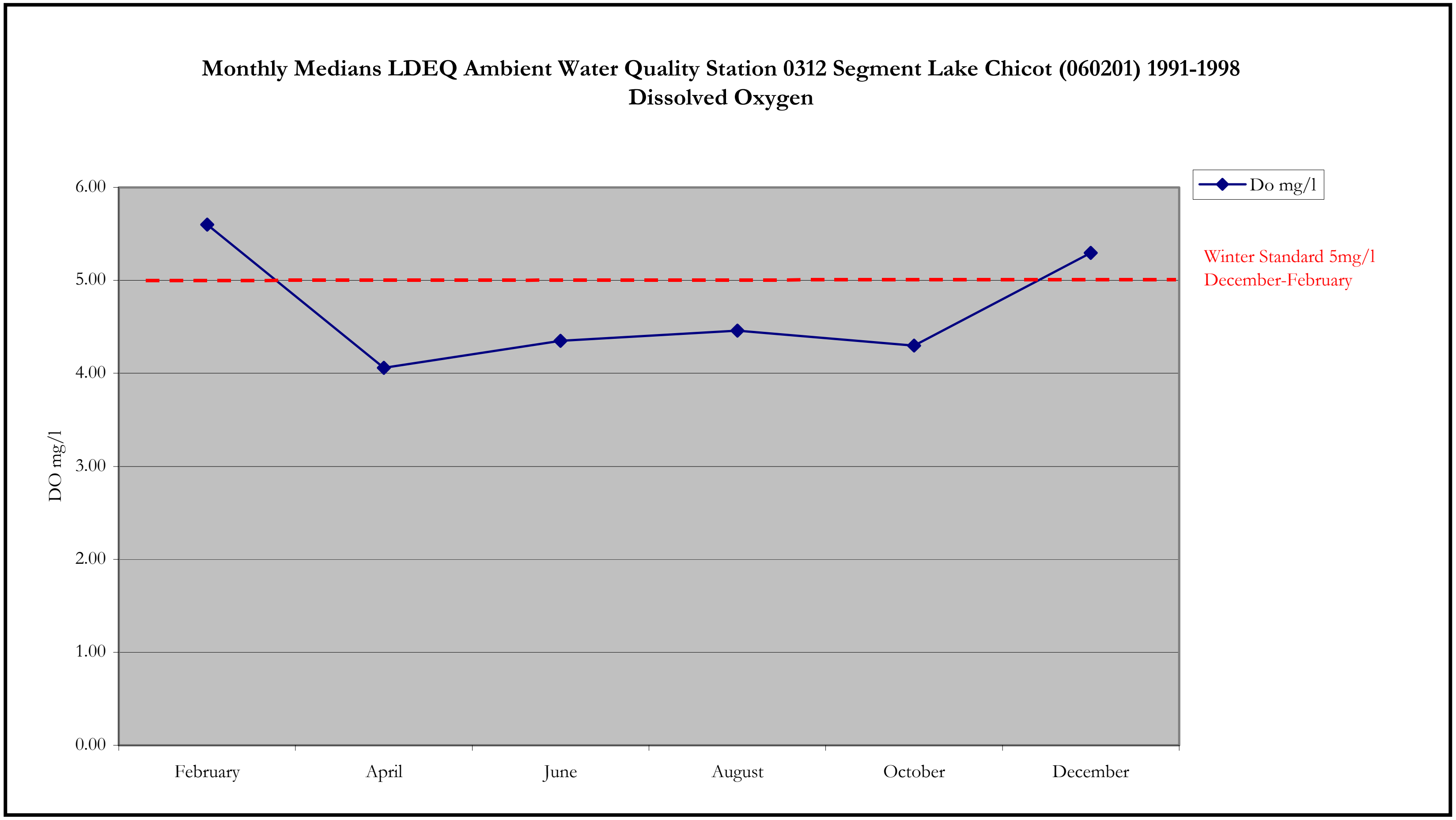
## Monthly Medians LDEQ Ambient Water Quality Station 0311 Segment (060102) Cocodrie Lake 1991-1998 Dissolved Oxygen

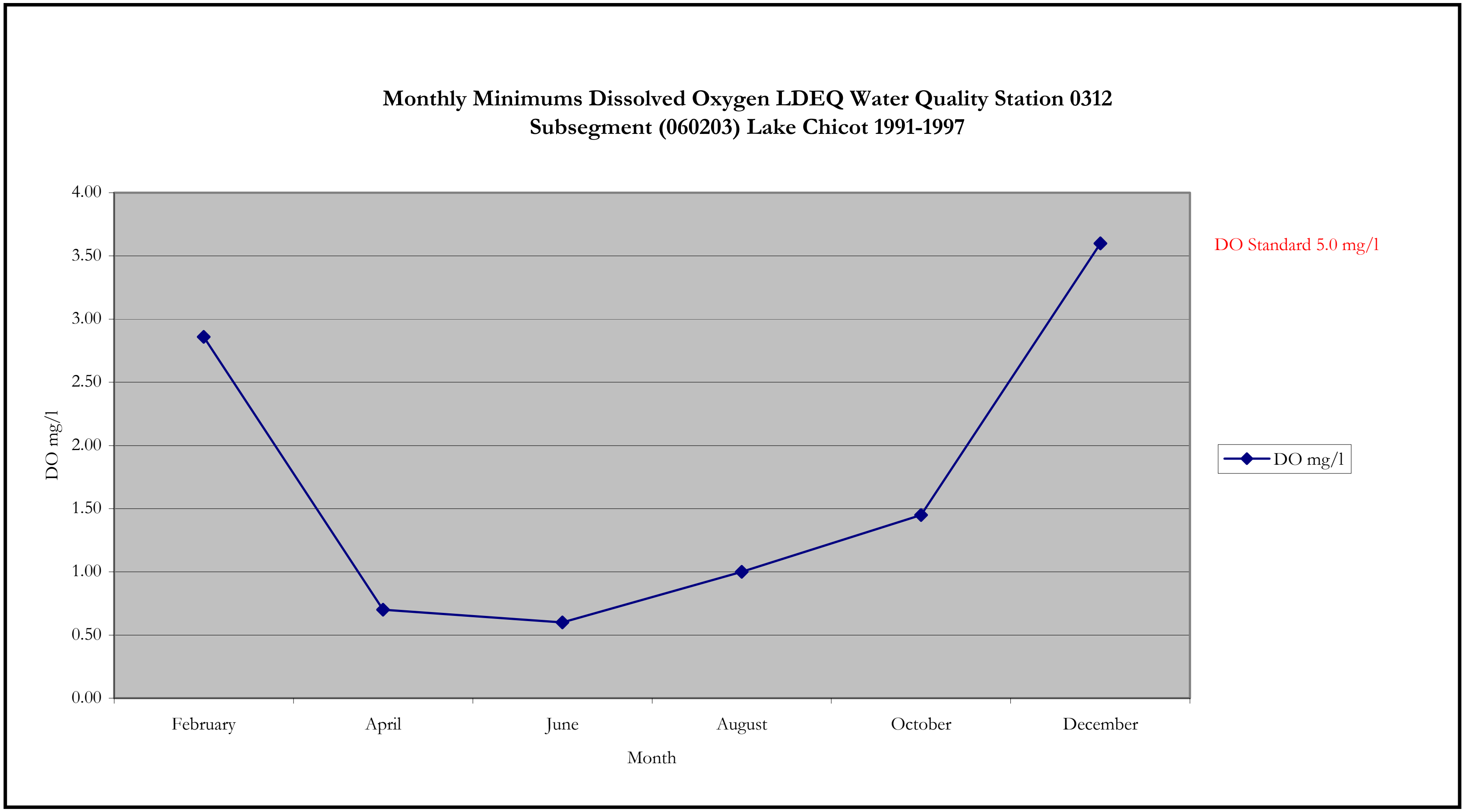
| 1991-1998 Dissolved Oxygen | Temperature | Dissolved oxygen | Total dissolved solids | Total suspended solids | Turbidity | NO2 Nitrate | Total Kjeldahl nitrogen | Total Phosphorus | Total organic carbon |
|---|---|---|---|---|---|---|---|---|---|
| | Centigrade | (mg/L) | (mg/L) | (mg/L) | NTU | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| February | 11.30 | 5.90 | 70.00 | 6.00 | 18.00 | 0.02 | 0.51 | 0.05 | 9.05 |
| April | 18.22 | 3.96 | 69.00 | 8.00 | 8.60 | 0.02 | 0.53 | 0.05 | 7.35 |
| June | 24.60 | 3.00 | 86.00 | 10.00 | 5.00 | 0.02 | 0.59 | 0.06 | 8.00 |
| August | 27.36 | 3.64 | 92.00 | 12.00 | 3.30 | 0.02 | 0.38 | 0.05 | 6.10 |
| October | 20.00 | 4.54 | 92.00 | 11.00 | 6.50 | 0.02 | 0.45 | 0.04 | 6.10 |
| December | 12.10 | 5.70 | 98.10 | 6.00 | 8.50 | 0.02 | 0.39 | 0.04 | 10.80 |
| Criteria | | 3.5 mg/l summer<br>5mg/l winter | 260 mg/l | NA | 150 NTU | Naturally occurring range [1] | | | NA |

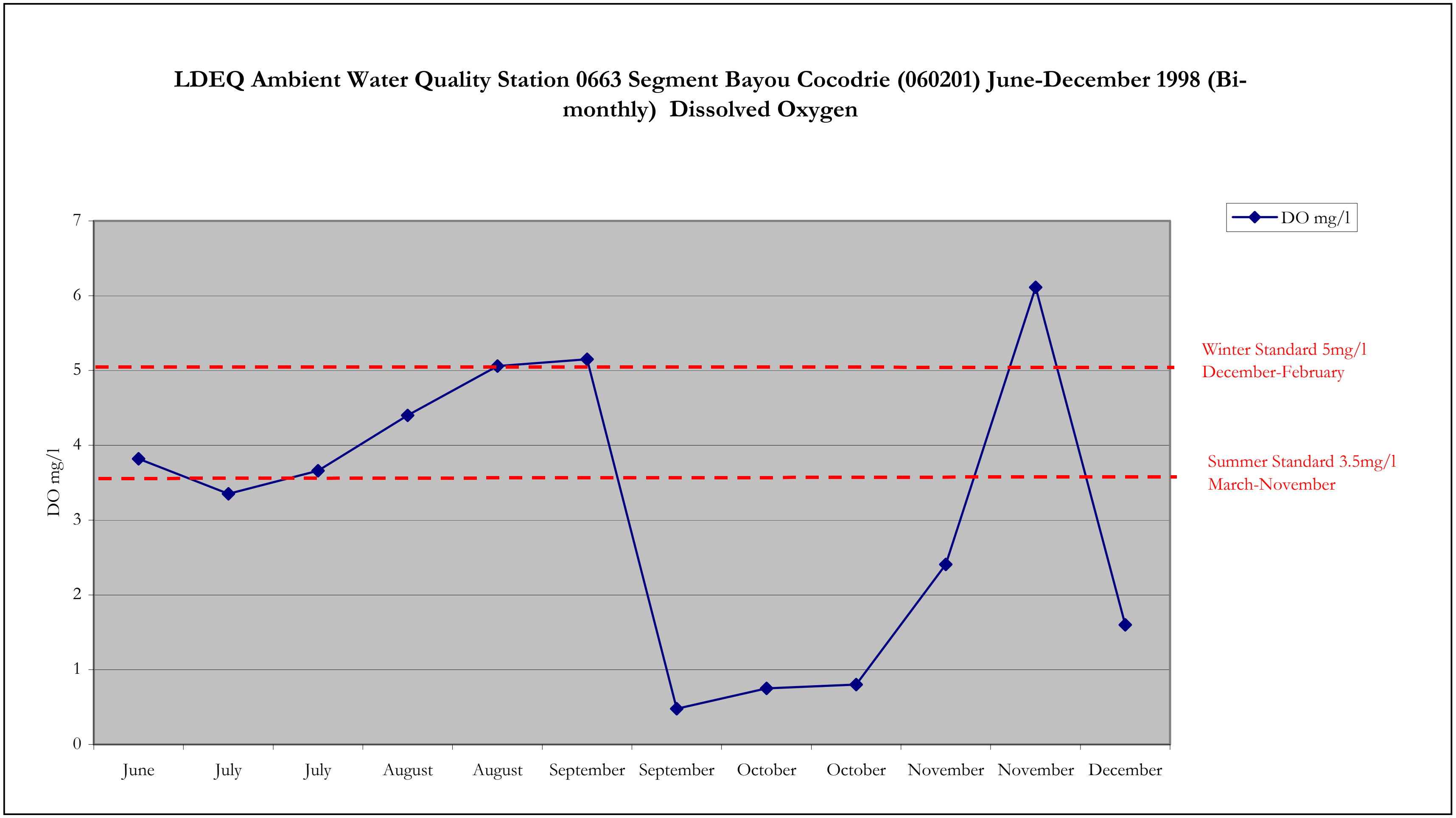
[1] The naturally occurring range of nitrogen-phosphorus ratios shall be maintained. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated uses shall not be added to any surface waters. LAC

## Annual Medians from 1991-1997 at Cocodrie Lake Subsegment (060102) Ambient Water Quality Station 0331

| YEAR | Temp | Dissolved oxygen | Total dissolved solids | Total suspended solids | Turbidity | NO2 Nitrate | Total Kjeldahl nitrogen | Total Phosphorus | Total organic carbon |
|---|---|---|---|---|---|---|---|---|---|
| | Centigrade | (mg/L) | (mg/L) | (mg/L) | NTU | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| 1991 | 21.23 | 4.35 | 93.00 | 6.50 | 8.90 | 0.02 | 0.56 | 0.05 | 9.85 |
| 1992 | 18.00 | 4.35 | 85.00 | 7.50 | 11.05 | 0.02 | 0.49 | 0.05 | 7.50 |
| 1993 | 19.52 | 4.15 | 76.00 | 11.00 | 9.00 | 0.04 | 0.37 | 0.03 | 7.75 |
| 1994 | 19.85 | 3.80 | 71.00 | 5.00 | 5.65 | 0.02 | 0.41 | 0.04 | 9.25 |
| 1995 | 19.00 | 3.15 | 76.00 | 11.00 | 6.00 | 0.02 | 0.55 | 0.07 | 9.15 |
| 1996 | 18.05 | 5.75 | 81.00 | 6.25 | 5.00 | 0.02 | 0.53 | 0.06 | 7.70 |
| 1997 | 18.22 | 3.97 | 87.05 | 8.00 | 11.50 | 0.03 | 0.59 | 0.07 | 8.60 |
| **20 yr avg** | **19.12** | **4.22** | **81.29** | **7.89** | **8.16** | **0.02** | **0.50** | **0.1** | **8.5** |
| Criteria | 3.5 mg/l summer<br>5mg/l winter | 260 mg/l | NA | | Naturally occurring range [1] | | NA | 150 NTU | NA |

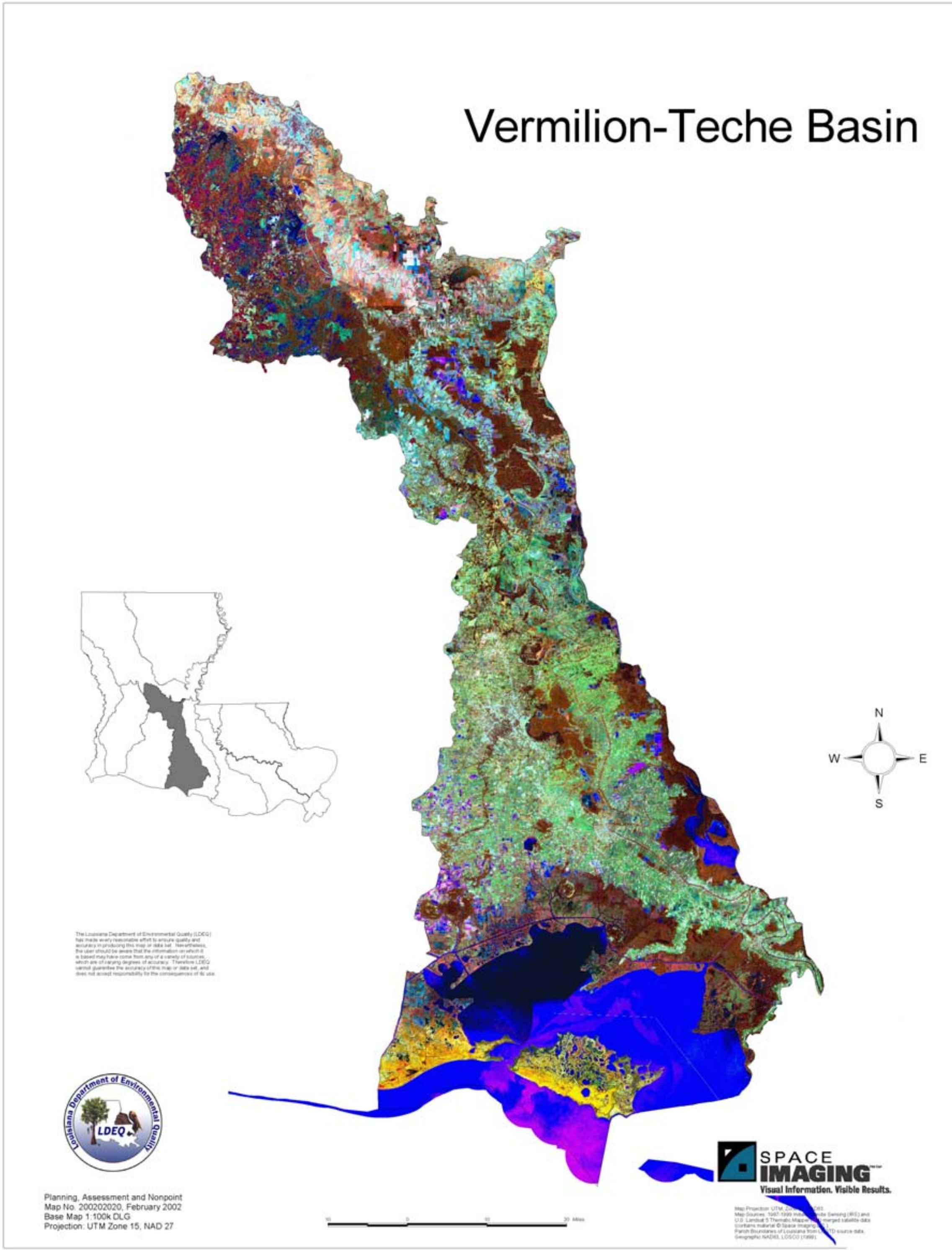

Monthly Medians LDEQ Ambient Water Quality Station 0312 Segment Lake Chicot (060201) 1991-1998
Dissolved Oxygen
DO mg/l
6.00
5.00
4.00
3.00
2.00
1.00
0.00
February
April
June
August
October
December
Do mg/l
Winter Standard 5mg/l
December-February

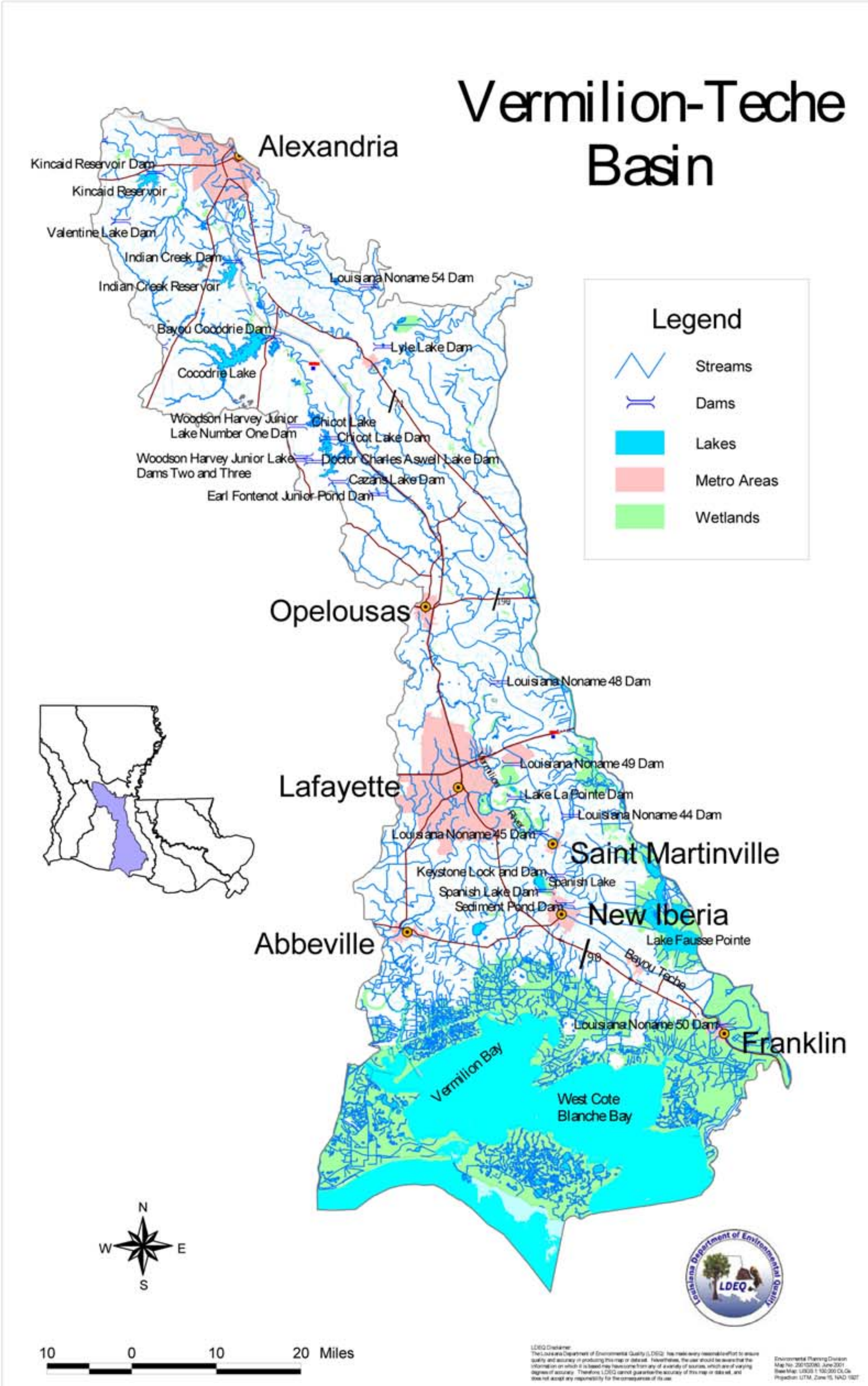

Monthly Minimums Dissolved Oxygen LDEQ Water Quality Station 0312
Subsegment (060203) Lake Chicot 1991-1997
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
DO mg/l
February
April
June
August
October
December
Month
DO Standard 5.0 mg/l
DO mg/l

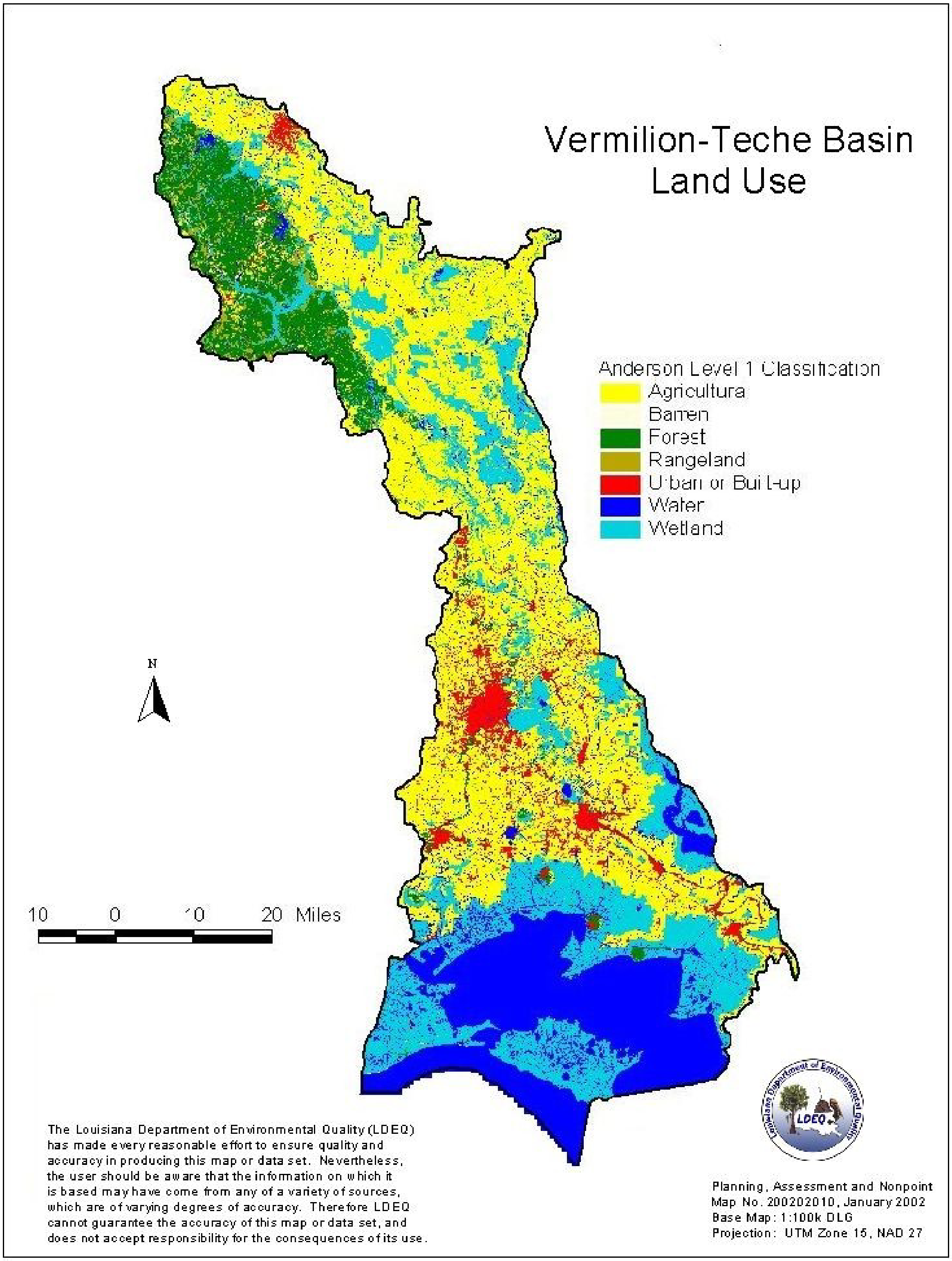

LDEQ Ambient Water Quality Station 0663 Segment Bayou Cocodrie (060201) June-December 1998 (Bi-monthly) Dissolved Oxygen
DO mg/l
7
6
5
4
3
2
1
0
June
July
July
August
August
September
September
October
October
November
November
December
DO mg/l
Winter Standard 5mg/l
December-February
Summer Standard 3.5mg/l
March-November

## 3.0 Basin and Eco-region

The Vermilion-Teche Basin has many physical and hydrological characteristics features common to both the Mermentau and Calcasieu River basins. All of these basins lie predominately within Louisiana's Western Gulf Coastal Plain (WGCPE) ecoregion. Marshlands are the major land features in the southern portion of the basin and prairie land predominantly characterizes the northern half of the basin. The basin begins at the western terminus of the Mississippi River floodplain along the Teche Ridge and is bounded by the West Atchafalaya Basin Protection Levee (WABPL) to the east and the Mermentau River Basin a short distance to the west. Located in south central Louisiana, this basin contains three major waterways, the Vermilion River and Bayou Teche in the southern area and the Bayou Boeuf watershed in the northern area. The Vermilion-Teche basin has flood plains which average only about 30 feet above sea level, ranging from less than 25 feet above mean sea level (msl) in the southern end of the study area to about 90 feet above msl in the headwater area of Bayou Boeuf (USACE, 1998). As in both the Mermentau and Calcasieu River basins, the Vermilion-Teche basin is subject to backwater flooding along waterways as a result of the low relief and flat contour of the land. Swamps and bayous of the region exhibit naturally dystrophic conditions with slow flows that result in lower reaeration rates. Channelization for flood control and control structures for saltwater intrusion (and in some instances navigation) has created uniform water depths, reduced flow gradients and velocities in the Mermentau, Calcasieu and Vermilion-Teche River Basins. Additionally, DO concentrations are directly related to water temperature. The most severe DO depletions occur at higher water temperatures. Therefore, the lower DO concentrations (less than 5 mg/L) associated with naturally dystrophic waters typically manifest seasonally during the warmer months of the year. Seasonal depletion of DO is also related to physio-chemical, hydrological, and geological characteristics.


Vermilion-Teche Basin
N
W
E
S
Louisiana Department of Environmental Quality
LDEQ
SPACE
IMAGING
Visual Information. Visible Results.
Planning, Assessment and Nonpoint
Map No. 200202020, February 2002
Base Map 1:100k DLG
Projection: UTM Zone 15, NAD 27


Vermilion-Teche Basin
Legend
Streams
Dams
Lakes
Metro Areas
Wetlands
Alexandria
Kincaid Reservoir Dam
Kincaid Reservoir
Valentine Lake Dam
Indian Creek Dam
Indian Creek Reservoir
Louisiana Noname 54 Dam
Bayou Cocodrie Dam
Lyle Lake Dam
Cocodrie Lake
Woodson Harvey Junior Lake Number One Dam
Chicot Lake
Chicot Lake Dam
Woodson Harvey Junior Lake Dams Two and Three
Doctor Charles Aswell Lake Dam
Cazans Lake Dam
Earl Fontenot Junior Pond Dam
Opelousas
Louisiana Noname 48 Dam
Louisiana Noname 49 Dam
Lafayette
Lake La Pointe Dam
Louisiana Noname 44 Dam
Louisiana Noname 45 Dam
Saint Martinville
Keystone Lock and Dam
Spanish Lake
Spanish Lake Dam
Sediment Pond Dam
New Iberia
Abbeville
Lake Fausse Pointe
Bayou Teche
Louisiana Noname 50 Dam
Franklin
Vermilion Bay
West Cote Blanche Bay
N
W
E
S
10
0
10
20
Miles
LDEQ


Vermilion-Teche Basin
Land Use
Anderson Level 1 Classification
Agricultura
Barren
Forest
Rangeland
Urban or Built-up
Water
Wetland
N
10 0 10 20 Miles
The Louisiana Department of Environmental Quality (LDEQ)
has made every reasonable effort to ensure quality and
accuracy in producing this map or data set. Nevertheless,
the user should be aware that the information on which it
is based may have come from any of a variety of sources,
which are of varying degrees of accuracy. Therefore LDEQ
cannot guarantee the accuracy of this map or data set, and
does not accept responsibility for the consequences of its use.
Planning, Assessment and Nonpoint
Map No. 200202010, January 2002
Base Map: 1:100k DLG
Projection: UTM Zone 15, NAD 27

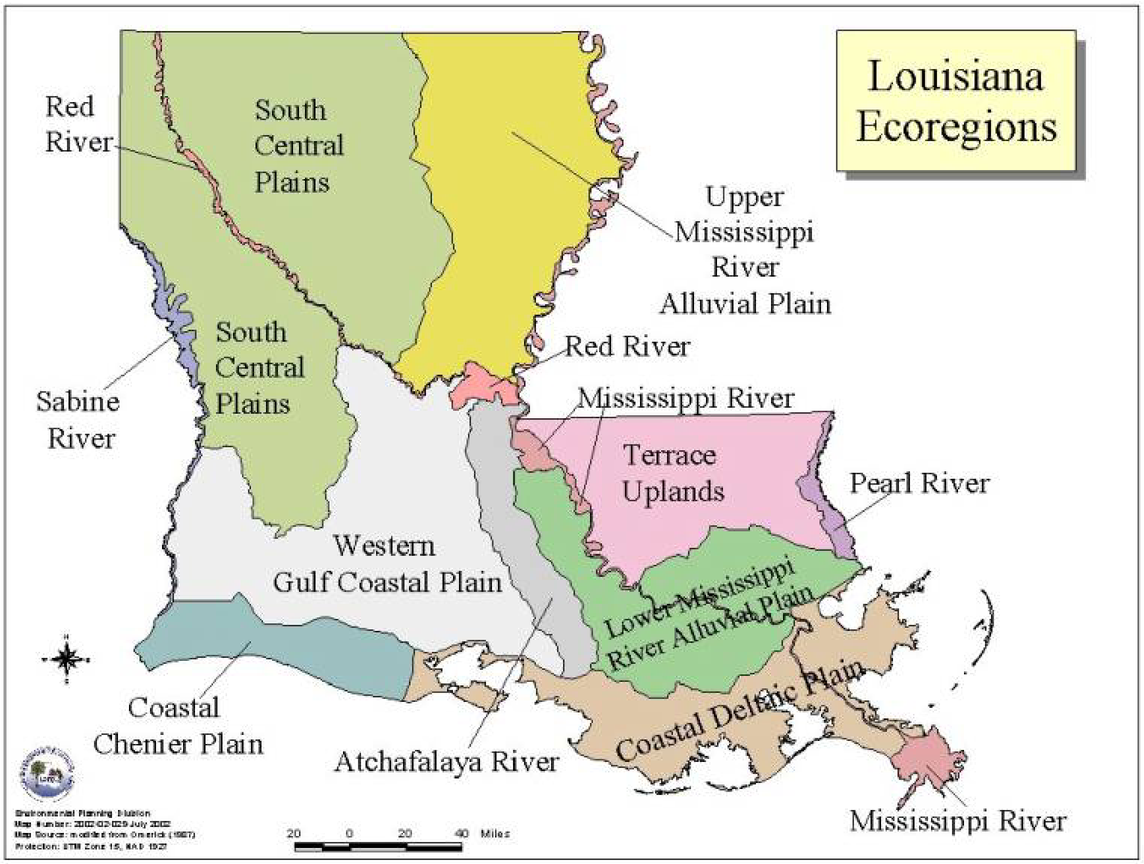



**Figure 3.2** The State of Louisiana is divided into 12 Eco-Regions characterized by unique soils, fauna, and agricultural crops. The Bayou Cocodrie is located in the Western Gulf Coastal Plains.

## 3.2 DESCRIPTION OF LOUISIANA ECO-REGIONS

Bayou Cocodrie is located within Western Gulf Coastal Plain Ecoregion (WGCPE) in Southwest Louisiana. The WGCPE is bounded to the north by the South Central Plains Ecoregion, to the south by the Intracoastal Waterway, to the west by the Sabine River, and to the east by the Atchafalaya River. The ecoregion includes portions of the Sabine, Calcasieu, Mermentau, and Vermilion basins. Drainage basin boundaries and downstream estuarine waters isolate the four major river systems within the ecoregion. The ecoregion lies above tidal areas, except under extreme drought conditions; therefore, tidal influences areas generally excluded. Although there are several types of vegetation present in the northern area of the ecoregion, 60 – 70% of the WGCPE has historically been a seasonally wet prairie. The prairie was maintained as a mosaic of treeless plains and tree lined river corridors by the presence of an impermeable, calcareous clay layer that prevented downward percolation or upward capillary action of water into the shallow soils. Disjunction of this clay layer at stream margins allows trees to grow for a few hundred feet on wither side of the stream. This clay layer allows water to stand during wet seasons, supporting the dominant land use of the area, rice cultivation.

# 4.0 NONPOINT SOURCE (NPS) LOADINGS INTO THE COCODRIE WATERWAYS

## 4.1 INTRODUCTION

Land uses such as agriculture, urban, industry, and natural systems contribute to the loading of chemical, mineral, and biological elements to the waterways. Hydromodification affects the transport of water through the stream networks and often reduces the capacity of riparian zones to retain sediments on stream banks. Residential home sewage from faulty septic systems also contributes to the nutrient and organic loadings to the waterways. NPS pollutant loadings to the Bayou Cocodrie are the result of three main sources: agriculture, urban, and natural background. The majority of the land is forest and wetlands. Discussed below are the suspect sources that contribute oxygen-demanding substances to the Cocodrie and its tributaries.

## 4.2 AGRICULTURE

The primary agricultural crops in the Bayou Cocodrie watershed consist of rice, soybeans, a few fields of sugarcane, and grazing pasture, and there is some aquaculture in the form of crawfish farming during the winter months. Rain events suspend sediments, fertilizers, and pesticides and transport the agriculture runoff to the reaches of the bayou. Runoff from fields soon after tillage operations, fertilizer applications, and other field operations contains greater levels of sediments and pollutants. During the late winter and early spring, large volumes of very turbid water have been observed flowing downstream in the waterways, and this has been associated with planting activities in adjacent rice fields. The cumulative effect of agricultural nonpoint pollutants results in potentially damaging concentrations of nitrogen, phosphorus, sediments, turbidity, and pesticide residue in the water bodies. The primary mechanism to reduce the amount of sediment and nutrients entering the waterbody is for the farmers to adopt Best Management Practices (BMPs) in order to meet TMDL objectives for the watershed. LDEQ and NRCS composed a list of seven types of BMPs that can be utilized to reduce agricultural NPS loading.

## 4.3 URBAN RUNOFF

Recent water quality monitoring studies in urban areas have shown that the highest pollutant loading and concentrations usually occur during rainfall events in the first runoff of rain, commonly referred to as the "first flush." In urbanizing an area, impervious surface area such as streets, parking lots, and rooftops, is increased. These smooth, impenetrable surfaces allow little or no detention or infiltration of stormwater. Pollutants that are present between rainfall events in the atmosphere prior to a storm and which accumulate on impervious surfaces are generally carried away in the first 0 to 1 inch of rainfall in moderate to heavy urbanized areas. As precipitation falls on urban areas, it picks up contaminants from the air, littered and dirtied streets and sidewalks; petroleum residues from automobiles, exhaust products, heavy metals and tar residuals from the roads; chemicals applied for fertilization, weed and insect control;

and, sediments from construction sites. The dumping of chemicals such as used motor oil and antifreeze into storm sewers is another source of urban NPS pollution. Illegal hookups of storm drains to sanitary sewers can result in increased volumes of flow to waste water treatment plants causing more frequent overflows of sewerage into receiving waters.

Urbanization has a profound impact not only on water quality, but on the hydrologic characteristics of watersheds as well. In undeveloped natural drainage areas, the volume and rate of stormwater runoff from a particular rainfall event is primarily determined by the natural detention and infiltration characteristics of the land, and is related to topography, soil types, and vegetative cover. With less detention and infiltration due to impervious surfaces, runoff volume increases, as well as, the rate of stormwater runoff. Flooding and stream channel degradation in urbanizing watersheds has obvious adverse impacts upon public convenience, safety, and aesthetics, but there are some significant adverse impacts on water quality as well. When streams overflow their banks, there is an increased opportunity for pollutants including trash and debris to enter the flow of water. Erosion of the stream channel represents a significant source of sediment pollution, and the loss of vegetation along stream banks reduces the pollutant assimilation capacity of a stream.

### 4.4 Hydromodification

Hydrologic modifications are defined as those activities, which are designed to affect natural stream flow. These types of modifications include bank stabilization, channel alignments, high-flow cutoff devices, instream construction, dredging, locks and dams, levees, spillways, and impoundments. Dredging, channel modifications, and impoundments are a major contributor to the nonpoint source pollution problem. Currently, all of these activities are being pursued in Louisiana waters, mainly for purposes of navigation and flood protection in coastal areas.

### 4.5 Home Sewerage

A significant portion of Louisiana's NPS pollution can be attributed to sewerage runoff from homes, camps, and businesses that are not connected to municipal sewerage treatment facilities. It is estimated that 1,323,600 people in Louisiana treat and dispose of their sewerage with individual waste disposal systems, and that over 50% of these systems are malfunctioning because of incompatible soil types or lack of maintenance. These failing systems are a major cause for water quality degradation in Louisiana's scenic streams and fresh water aquifers. Septic tank systems normally consist of two components, a treatment unit and a disposal unit. The septic tank and soil absorption system is the most common individual waste disposal system used in Louisiana. The purpose of the septic tank is to condition household wastes so that the discharge will readily percolate into the soil. This conditioning is done in a septic tank by the removal of solids by settling and also by decomposition of the soluble organics. The soil then provides additional treatment by the removal of bacteria, organics, and nutrients. One of the main problems with using conventional septic tank soil absorption systems in Louisiana is that 87 percent of the soil associations in Louisiana are considered inadequate for conventional septic tank systems as determined from the Soil Limitation Ratings for Sanitary Facilities. Another major component to the pollution caused by septic tank systems is inadequate enforcement of the State Sanitary Code. A properly designed septic tank consists of a buried, watertight, multiple compartment tank, usually of concrete material, equipped with inlet and outlet devices and scum control baffles.

# 5.0 Physical, Chemical, and Biological Causes for Oxygen Depletion

## 5.1 Sediment Oxygen Demand and Reaeration

The slope of the Cocodrie is very gradual and the potential for reaeration is low. The bayou is slow moving and depositional in nature, resulting in continued sedimentation within the streambed. The watershed rests on an alluvial plain where soils are composed of silty loams and clays (see soils map). Organic matter attaches to the clay and silts and creates an oxygen demand as the particles decompose within the waterway. After time, this process results in a layer of muck along the streambed. This layer of muck creates what is commonly referred to as sediment oxygen demand (SOD). Agriculture is the largest contributor to the accumulation of sediments and nutrients to the waterway. Rain events suspend exposed soils and fertilizers, transport them overland, and deposit them in the bayou. Nutrients encourage the growth of aquatic plants and nitrifying bacteria. Respiration consumes DO and the decomposition of the organisms contributes to SOD and/or eutrophication. Sediment oxygen demand is the amount of oxygen consumed by the bacteria as they attack the organic material that has settled or been captured to form a sediment or sludge deposit. Composed largely of particles of organics attached to sediments, feces, dead algae, and decaying plant matter, the accumulated sediments can dominate oxygen dynamics. Both winter and summer fish-kills in natural systems, caused by oxygen depletion, can be attributed to oxygen consumption by the sediments.

## 5.2 Carbonaceous Biochemical Oxygen Demand

The waterways contain particulate or dissolved organic materials that can serve as food for heterotrophic bacterial communities, which in turn consume large amounts of oxygen. The potential impact of these dissolved organics on the water's oxygen supply is estimated by measuring the water's carbonaceous biochemical oxygen demand (CBOD). The CBOD of a sample is measured by observing the oxygen drop in a sealed bottle over a fixed number of days (usually five). The number of days used in the test is indicated by a suffix, i.e., CBOD5. A high CBOD5 (>15 mg/l) implies that a lot of bacterial activity will occur in the water throughout the day and night as the bacteria attack the suspended or dissolved organics.

## 5.3 Nitrogenous Biochemical Oxygen Demand

The nitrogenous biochemical oxygen demand (NBOD) is a major cause of oxygen loss in aquatic systems. NBOD is a measure of the amount of oxygen that is consumed by the nitrifying bacteria as they convert total ammonia nitrogen (TAN) to nitrate. Approximately 4.57 milligrams of oxygen are consumed for each milligram of TAN converted to nitrate nitrogen. TAN is directly excreted into the water by a wide variety of aquatic organisms and is very difficult to remove without bacterial activity. Unless the water is rapidly flushed, the water's NBOD must be satisfied within the system. TAN is also produced as a by-product of the decay of sediments and sludges as the bacteria break down proteins and amino acids to form ammonia.

### 5.4 High Temperatures and Low Flow

Biochemical reactions, in general, follow the van't Hoff rule of a doubling of the reaction rate for a 10°C increase in temperature over a restricted temperature range. Therefore, temperature is strongly inversely proportional to dissolved oxygen levels. July and August are the hottest months in Louisiana, while October and November are the months with lowest stream flows. Dissolved oxygen and runoff are moderately directly proportional. The TMDL analysis concluded that critical conditions for stream DO concentrations were those of negligible nonpoint run-off and low stream flow combined with high stream temperature. When the rainfall and stream flow are high, turbulence is higher due to higher flow and the temperature is lowered due to rainfall run-off. Reaeration rates are much higher when water temperatures are cooler and BOD decay rates are much lower. For these reasons, periods of high loadings are periods of higher reaeration and DO but not necessarily periods of high BOD decay. LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for accumulated benthic blanket in the stream, which is expressed as SOD or re-suspended BOD. This accumulated loading (SOD) has its greatest impact on the stream during periods of higher temperature and lower flow. NPS pollutant loadings, primarily agriculture, are the major source of this SOD in the Cocodrie watershed.

## 6.0 Waste Load Allocation

### 6.1 Point Source Discharges in Bayou Cocodrie

There are 30 known dischargers in the watershed, the majority of which are too small to have a significant impact on water quality in the watershed. Limits for the small discharges are generally set by state policy. Only one of the point sources will require more stringent effluent limitation to meet dissolved oxygen criteria (City of Dawson Sewage Treatment Plant). Reductions from point sources will be addressed in revisions to discharge permits. Below is a table that compares the point source, headwaters and tributaries, incremental, and NPS discharges in the Bayou Cocodrie watershed:

### 6.2 TMDL BOD Load in Bayou Cocodrie

Cannot be determine at this time. TMDL needs to be rewritten to accommodate new standards.

## 6.3 LA QUAL Modeling Results

Cannot be determine at this time. TMDL needs to be rewritten to accommodate new standards.

## 6.4 TMDL Model Reaches

Cannot be determine at this time. TMDL needs to be rewritten to accommodate new standards.

## 6.5 Tributaries

Cannot be determine at this time. TMDL needs to be rewritten to accommodate new standards.

## 7.16 Soil Erodibility K-Factor

Soil Erodibility is a soil property that is defined as the ease with which soil is detached by a splash of rainfall or by surface flow or both. Physically, soil erodibility is the change in the soil per unit of applied external force or energy, namely rainfall or overland flow. The most erodable soils are along the bayou and tributaries and the most effective management plan for retaining soils in these areas is the implementation and maintenance of riparian zones. LDEQ is again recommending that riparian areas be installed all along the bayou and tributaries from the edge of the stream at bank full to 100 ft away from the river and streams.

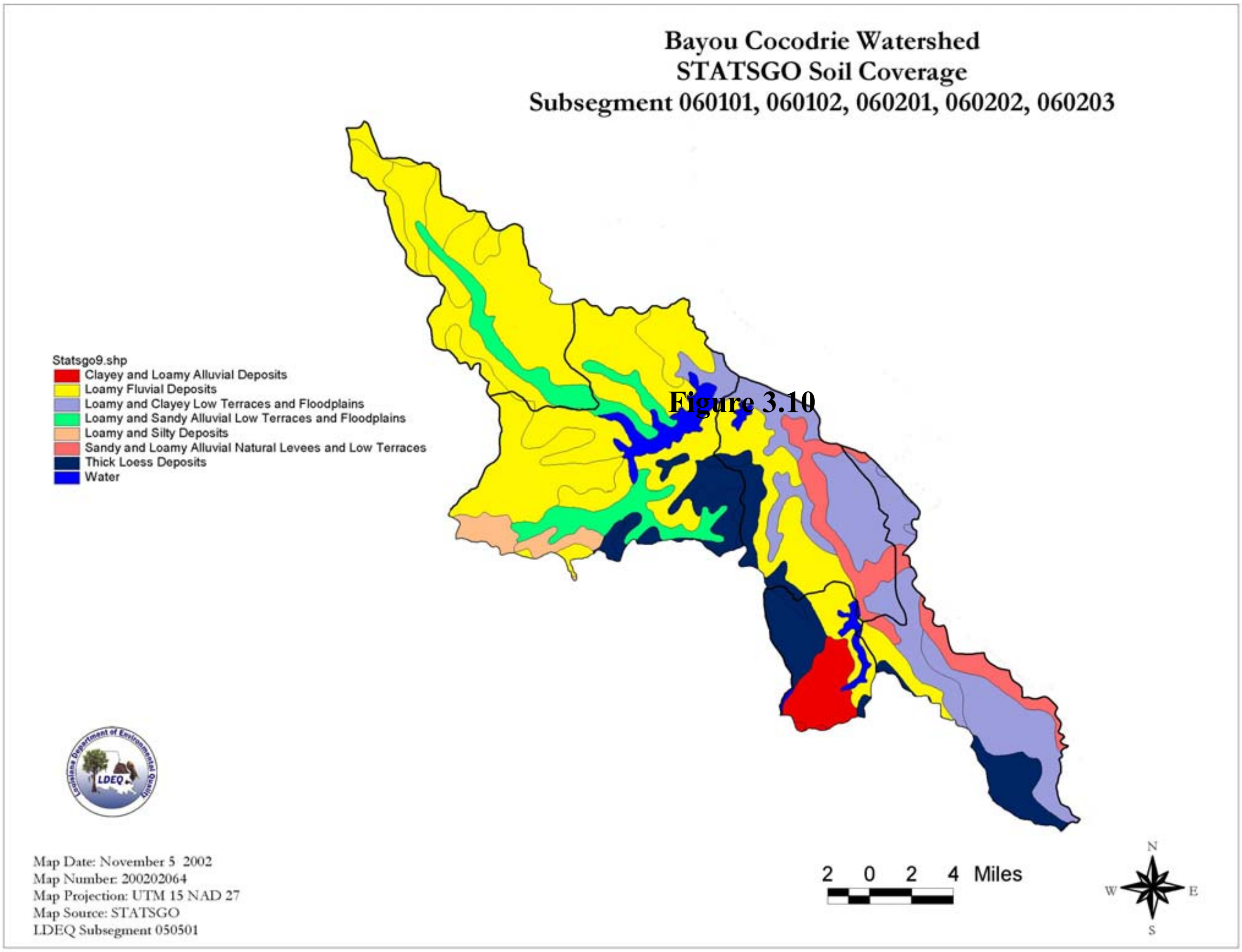



**Figure 7.13** STATSCO soils map. There are 8 general types of soils in the Bayou Cocodrie watershed that are predominantly silt loams.

### 7.17 ACHIEVING GOALS: BMP IMPLEMENTATION AND COST SHARE

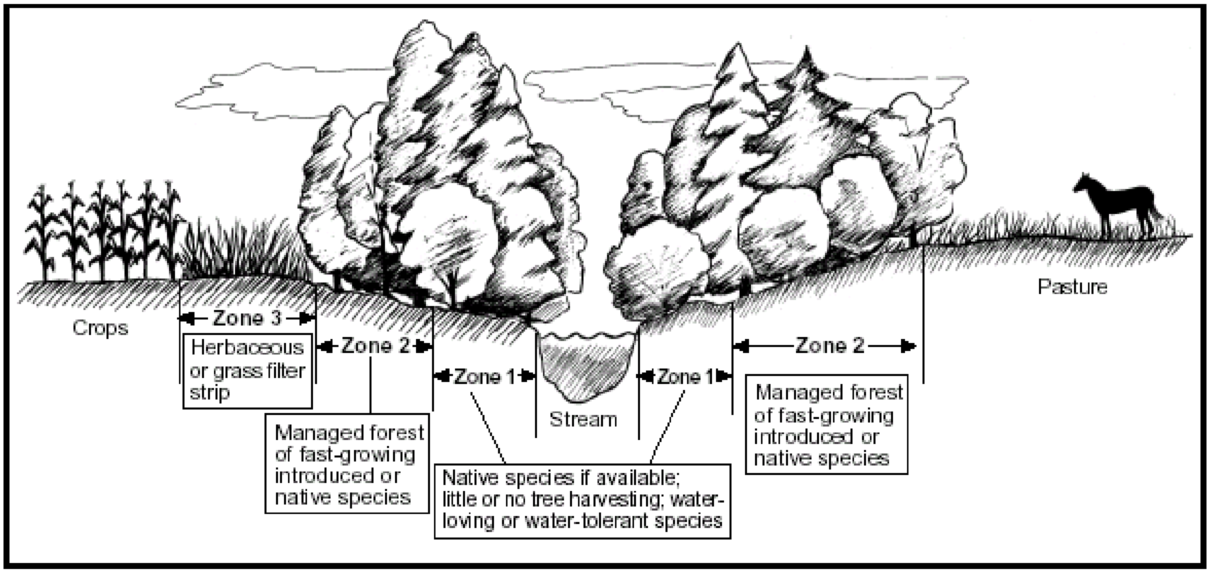
Cost share funding for BMPs is a key element in a successful Implementation Plan. A number of Federal and State funding sources exist for BMP implementation, riparian zones, and land conservation. The LDEQ Non-Point Source group provides USEPA §319(h) funding to assist in implementation of BMPs to address water quality problems on reaches listed on the §303(d) list or which are located within Category I Watersheds as identified under the Unified Watershed Assessment of the Clean Water Action Plan. USEPA §319(h) funds were utilized to sponsor the cost sharing and monitoring projects discussed above. These monies are available to all private, for profit and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Proposals are submitted by applicants through a Request for Proposal (RFP) process and require a non-federal match of 40% of the total project cost consisting of funds and/or in-kind services. Further information on funding from the Clean Water Act §319 (h) can be found at the LDEQ web site at: www.deq.state.la.us.

### 7.18 Other Federal and State funds

The U.S. Department of Agriculture (USDA) offers landowners financial, technical, and educational assistance to implement conservation practices on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat. One of these programs is the Conservation Reserve Program (CRP). It is designed to encourage farmers to convert highly erosive cropland to vegetative cover, such as native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive annual rental payment for the term of the multi-year contract. The Conservation Reserve Enhancement Program (CREP) combines the resources of the CRP program with that of the State government. This program focuses on NPS pollution and water and habitat restoration. The Environmental Quality Incentives Program (EQUIP) is another source of funding available to the farmers for conservation practices. These are a few of the State and Federal funding sources available to agricultural landowners that will help with the cost of reducing NPS run-off from their fields.

### 7.19 Achieving Goals: Riparian Zones

Riparian areas can be defined in numerous ways. The USDA – Forest Service defines it as "the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, flood plain, and wetlands. In specific cases, the riparian area may also include a portion of the hill-slope that directly serves as streamside habitat for wildlife." Because of landscape position, the riparian zone is ultimately linked to the stream channel and its aquatic ecosystems as well as the upland ecosystems. As a result they play a critical role in the hydrology of watersheds. Their typically long and narrow nature, along with their unique physical and biological processes, allow riparian zones to act as strategic buffers between upland and aquatic ecosystems. Although riparian zones may occupy as little as 1% of the land area of a watershed, these ecosystems are among the most productive in the landscape. Some of their most important functions are filtering and retaining sediment; immobilizing , storing, and transforming chemical inputs from uplands; controlling stream environments and morphology; controlling aquatic and terrestrial habitats; providing water storage and recharge of subsurface aquifers; and, reducing floods.




A riparian forest buffer includes zone 1, the area closest to the waterbody or course, and zone 2, the area adjacent to and up gradient of zone 1. Trees and shrubs in zone 1 provide important wildlife habitat, litter fall for aquatic organisms, and shading to lower water temperature. This zone helps stabilize streambanks and shorelines. Trees and shrubs in zone 2 (along with zone 1) intercept sediment, nutrients, pesticides, and other pollutants in surface and subsurface water flows. Zone 2 can be managed to provide timber, wood fiber, and horticultural products. A third zone, zone 3, is established if periodic and excessive water flows, erosion, and sediment from upslope fields or tracts are anticipated. Zone 3 is generally of herbaceous plants or grass and a diversion or terrace, if needed. This zone provides a "first defense" to assure proper functioning of zones 1 and 2.

**Figure 7.14** Above is an illustration of the 3 riparian zones

## 7.20 Riparian Forest Buffers have three distinct zones

Zone 1 is a 5m wide strip of undisturbed mature trees that begins at the edge of the stream bank and provides the final filter for materials moving through the buffer. The purpose of this zone is to create an undisturbed, stable ecosystem that provides bank stability, an environment for dissolved soil water nutrients to interact with the "living filter" including plants that shade the stream stabilizing water temperatures and provide both fine particulate organic matter and large woody debris to the stream. Over mature trees are valued as they provide large woody debris for the stream. As part of forestry BMPs, logging equipment is excluded except at designated stream crossings. Likewise, grazing is excluded for this zone.

Zone 2 is adjacent to Zone 1 and is a zone of trees at least 18m wide and managed to provide maximum infiltration of surface runoff and nutrient uptake and storage while also providing organic matter for microbial processing of agrochemicals. The purpose of this zone is to provide the necessary contact time for biological processes associated with microbial activity and to provide plant uptake to remove NPS pollutants from the soil and water column. Multiple-use management for timber and wildlife can be compatible with NPS removal.

Zone 3 is a zone of grazed or ungrazed grass, a minimum of 6m wide, which converts concentrated flow from the upland to sheet flow, either naturally or by the use of structures.

This zone filters sediment from the sheet flow and causes the water and agrochemicals to infiltrate into the biologically active rooting zone where nutrient uptake and microbial processing occurs. The zone is composed of grasses and forbs that must be removed to provide effective nutrient sequestering. Grazing is allowed when earthen control structures are not damaged. Occasional reshaping of structures and removal of accumulated sediment may be necessary to maintain proper function

### 7.21 Conservation Reserve Program (CRP)

The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation (CCC). CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning.

The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodable cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. Currently, CRP is financially the most lucrative program the USDA offers to eligible farmers and ranchers with a 50% cost-share, an additional 40% practice incentive payment, a $10/acre X length of contract signing bonus, as well as an annual rental rate of approximately $30/acre.

### 7.22 Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program (EQIP) was established in the 1996 Farm Bill to provide a voluntary conservation program for farmers and ranchers who face serious threats to soil, water, and related natural resources. Nationally, it provides educational assistance primarily in designated priority areas. About half of the program is targeted towards livestock related natural resource concerns and the remainder goes to other significant conservation concerns.

EQIP offers 5-to 10-year contracts that provide incentive payments and cost-sharing for conservation practices called for in the site-specific conservation plan. All EQIP activities must be carried out according to a conservation plan that is site specific for each farm or ranch. Producers can develop these plans with help from the NRCS or other service providers.

Cost-sharing may pay up to 75% of the costs of certain conservation practices such as grassed waterways, filter strips, manure management facilities, capping abandoned wells, and other practices important to improving and maintaining the health of natural resources in the area. Incentive payments may be made to encourage a producer to perform land management practices such as nutrient management , manure management, integrated pest management, irrigation water management, and wildlife habitat management. Total cost-share and incentive payments are limited to $10,000 per person/year and $50,000 for the length of the contract. These payments may be provided for up to three years.

### 7.23 Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentive Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private lands. It provides both technical assistance and cost-share payments to help establish and improve fish and wildlife habitat.

The objectives of WHIP are to implement parts of the eligible participant's conservation plan that create and enhance wildlife habitat, provide program participants informational and educational support regarding wildlife habitat needs, and foster a positive public attitude towards wildlife, wildlife habitat, and land stewardship. This will be accomplished by participants entering into a WHIP agreement to provide financial assistance in the form of cost-share payments to enhance habitat on eligible land.

Cost-share assistance is provided in 5-to 10-year agreements provided the landowner agrees to install and maintain the WHIP practices and allow the NRCS or its agent access to monitor the effectiveness of the practices. In return, the USDA agrees to provide technical assistance and pay up to 75% of the cost of installing the wildlife habitat practices.

### 7.24 TMDL Monitoring Schedule

As LDEQ continues to monitor the water bodies across the state on the 5-year basin cyclic program, annual progress made in BMP implementation will be documented and reported to EPA, the NPS Interagency Committee and the general public through LDEQ's website. The first cycle of water quality monitoring will utilize the data collected to develop the TMDL and devise the watershed restoration action strategy. The second cycle will provide baseline data for TMDL Implementation Plan and third cycle will determine whether the Implementation Plan has been effective in reducing nonpoint source pollutants and improving water quality within the water body. If this third cycle of water quality monitoring does not indicate a significant improvement in the implementation of agricultural best management practices within the watersheds on the 1998 303(d) list, then LDEQ and the cooperating federal and state agencies will determine whether back-up authorities are necessary to achieve the BMP implementation required to reduce nonpoint sources of pollution and improve water quality.

### 7.25 Future Objectives and Milestones: The Master Farmer Program

The objective is to get as many of the landowners in the Bayou Cocodrie watershed to implement BMPs as possible and to restore the designated uses back to the bayou in 10-15 years. As outlined in the TMDL, it will require a 50% reduction in NPS pollution. Restoration will require the implementation of BMPs, not only in the two subwatersheds mentioned above, but throughout the watershed. LSU AgCenter is promoting the Master Farmer Program to help farmers address environmental stewardship through voluntary, effective, and economically achievable BMPs. The program will be implemented through a multi-agency/organization partnership including the Louisiana Farm Bureau (LFBF), the Natural Resources Conservation Service (NRCS), the Louisiana Cooperative Extension Service (LCES), USDA-Agriculture Research Service (ARS), LDEQ, and agricultural producers.

The Master Farmer Program will have three components: environmental stewardship, agricultural production, and farm management. The environmental stewardship component will have three phases. Phase I will focus on the environmental education and crop-specific BMPs and their implementation. Phase II of the environmental component will include in-the-field viewing of implemented BMPs on "Model Farms." Farmers will be able to see farms that document BMP effectiveness in reducing sediment runoff. Phase III will involve the development and implementation of farm-specific, comprehensive conservation plans by the participants. A member must participate in all three phases in order to gain program status.

This program can help to initiate and distribute the use of BMPs throughout the Cocodrie watershed. The members will set an example for the rest of the agricultural community. They will work closely with scientists and other Master Farmers to identify potential problem areas in the watershed. They will receive information on new and innovative ways to reduce soil and nutrient loss from their fields. They will be kept abreast of the water quality monitoring occurring in the watershed and alerted of any degradation or improvements. The Master Farmer Program will allow stakeholders and agencies to observe the acceptance of BMPs throughout the watershed and they will help LDEQ observers track the implementation of soil management plans.

The solutions to controlling runoff will require the joint efforts of agriculture producers, landowners, government, private citizens and private organizations working together. The Louisiana Cooperative Extension Service (LCES) and Louisiana State University (LSU) AgCenter conducted a commodity-specific BMP review. These reviews were conducted through a multi-agency/organization partnership made up of research and extension scientists, the Louisiana Farm Bureau (LFBF), the Natural Resources Conservation Service (NRCS), the LDEQ, USDA-Agriculture Research Service (ARS), and agriculture producers.